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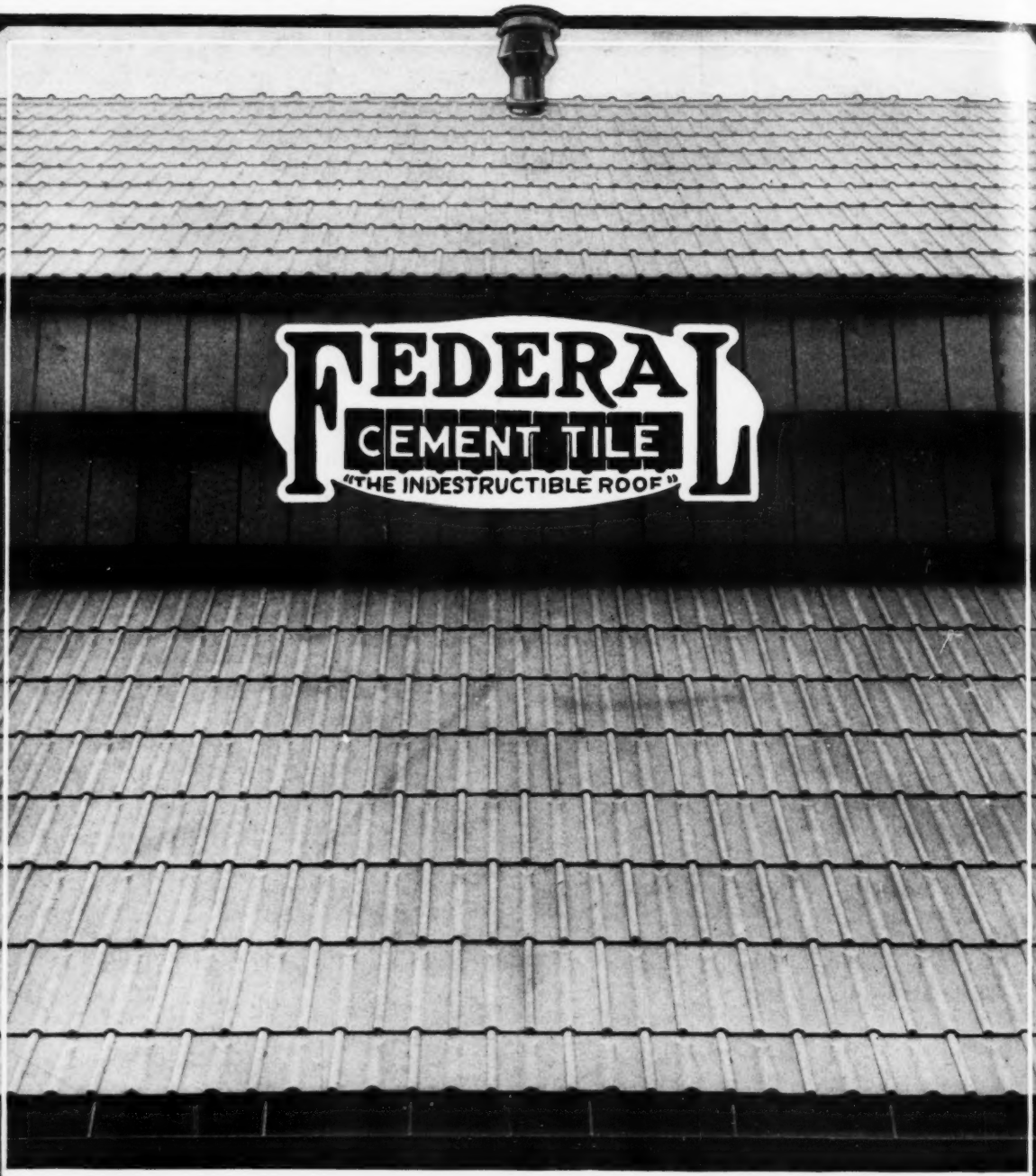
World's Greatest Water-Works, to be Dedicated Tomorrow

Map Shows Vast Extent of Catskill Aqueduct System for New York's Additional Water Supply.

In This Issue:

The Catskill Aqueduct Engineering Organization.



THIS IS THE 16-POUND *CONCRETE* ROOF

used so successfully by the largest Railroad companies in the United States and made in interlocking units, 2 ft. wide, 4 ft. long, 1 inch thick, resting directly on light purlins, spaced 4 ft. centers, eliminating wood sheathing. Note the absence of composition covering.

The Pennsylvania Railroad used this material on a freight shed two blocks long. The Illinois Central Railroad deemed it economy to cover their 1200-foot Car Repair Shed at Nonconnah, Tenn., with this interlocking tile; and after searching the entire roofing industry for a logical roof the Kansas City Terminal Company chose "Federal" as their covering.

Write for our booklet, "The Indestructible Roof," and blueprint details
Let us tell you how these tiles are made, laid and guaranteed by

FEDERAL CEMENT TILE COMPANY

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ENGINEERING NEWS-RECORD

A WEEKLY JOURNAL
DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

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The Demand for Civil Engineers

APROPOS of our recent treatment of the status of the engineering profession at this time of crisis, it is impressive to note that at least in some sections of the country the position of the engineer is not anomalous, but that on the contrary he occupies a well-defined place in the social scale and one, incidentally, which must be taken into consideration by every citizen. In a Dallas, Tex., daily paper there appeared recently the following advertisement: "Wanted at once—40 civil engineers, handy men, cooks, dishwashers and other high-class positions open. . . ."

Jersey City Will Let the Court Decide

THE unanimous decision of the authorities of Jersey City to let the Chancery Court itself decide whether it will permit a retrial of the water-supply contract suit, as suggested on page 481 of our issue of Sept. 13, opens a question of possible interest to every engineer or other expert who serves as a witness in contested contract cases, as well as to contractors, utility companies and municipalities. The broad question at issue is whether a suit can be reopened when it is plain to any judge or layman that the data of years of experience give ground for a directly opposing decision from that rendered on honest but premature expert opinion some years before, at a time when a new art was being given its first large-scale working test. The specific sanitary point involved is that all experts now agree that chlorination alone is not a complete bacterial defense against water pollution. Witnesses who testified in the first days of the art that chlorination alone was sufficient to meet the conditions of the Jersey City water-supply contract have since admitted their overconfidence and are now ready to go on the witness stand and say so. Jersey City has done well to let the court itself decide whether the case can be opened.

No Fee Contracts for War Building

WE ALL know that you cannot have your cake and eat it too. Nevertheless the wise men of Washington who are agitating for straight-fee construction contracts and competitive bidding on the fee are trying to tell us that you can secure by this simple system the advantage of cheapness attainable with competitive bidding and the incompatible advantage of great speed of construction attainable under percentage contracts. Where there is time to investigate all the conditions, complete a detailed design and allow contractors to estimate the cost carefully, and then to plan the work, competitive bidding may be held to promote efficiency. Where there is time for none of these things, but on the other hand where failure to finish the job at the earliest possible moment may mean the crippling of our offensive efforts, the percentage contract can be depended on, with efficient contractors of proved ability, to get the work done by the time it is needed and at the least reasonable cost. There is no necessity for resorting to a botched mixture of these two ways of handling work, grasping at the economy of one and the speed of the other, and insuring, as Mr. Goodell points out on page 687, the loss of both. If the Government cannot trust the ability and integrity of the country's best contractors, of whose services it has the pick, we had better pull our troops out of France before it is too late. On these same contractors must fall the burden of building all the facilities to transport and maintain our troops; and he who says these firms will prove crooked and inefficient on percentage work in the present emergency says in fact that we are without efficient men to carry out this essential step in our offensive program. The agitation for fee contracts is based on prejudice, not on fact and logic. The administration must disregard the agitators or they will do serious harm.

Technical vs. Social Programs

INTEREST in the social phase of engineering society work is general. It is a good symptom. Even the older, conservative engineers recognize more and more the need for drawing closer together, and are lending support to the increased social activities in engineering societies. But one danger is already in sight, as the experience of several societies indicates. That danger is the neglect of the technical work which—for most of the societies—is the bond of common interest. Once the participation of members in the reading and discussion of technical papers becomes less keen, or the social work is allowed to become ascendant, the society begins to go backward. There must be a solid basis of technical work if membership and prestige are to be increased. When speakers and papers must be drawn almost entirely from sources outside the society, and members are slow to make themselves heard, the beginning of the retrograde process is at hand. And such a condition is not a mere word-picture. Instances of such retrogression can be found. These thoughts are particularly appropriate just now. Programs for the winter are being laid out. On their character rests the welfare of the society as a truly engineering body.

English Considered as Mental Training

WHETHER Mr. Sutcliffe's contribution to the discussion of the most profitable method of teaching English, on page 599, Sept 27, is an advance over those proposed by Professors Park and Aydelotte in the *Engineering Record* of Feb. 24, 1917, will depend upon the answer it can return to the purely pragmatic question, "Does it work?" In considering the point he raises, we must remember that clear and sequential thinking is among the rarest of phenomena, and its attainment must be the definite aim of any reasonable system of pedagogics. Over the methods there may be many understandable, and indeed welcome, quarrels, but the primary object of education remains unclouded: The student is to be taught to think.

It will be recalled that Professor Park postulates that every engineering student is potentially a writer for publication, and that partly on this assumption of future authorship, all students in the College of Engineering at the University of Cincinnati are given a "course which consists of writing . . . as if for publication." Through an analysis of articles in various technical journals the student is given an opportunity to study their technique and to gain an idea of what would be an acceptable contribution, based upon a consideration of the elements of timeliness, originality, and practical usefulness. Therefore, Professor Park feels that journalistic assignments for his students should prove to be the best method of training, and consequently gives as subjects for themes matters directly connected with the students' work or neighboring construction.

On the other hand, Professor Aydelotte desires to "regard him [the student] as a member of an intellectual profession which has for its object the control of the human as well as the material forces of nature . . . a profession the members of which, working in cooperation, consider themselves the trustees of the whole body of natural knowledge placed at their disposal by modern science, and who consider their duty to be to add to this knowledge and to use it for the realization of the highest aims of society." He feels that more than merely technical proficiency should be expected from the engineering schools, calling upon these institutions to develop character and related human, though not necessarily professional, qualities. He holds that "the average engineering student has too narrow and too mechanical a view of his future profession . . . . not as a result of thought and choice but rather . . . . in obedience to a real or imaginary spirit of the age . . . which it has never occurred to him to criticise."

Therefore, whenever possible, Professor Aydelotte breaks away from purely engineering subjects and tries to have the student gain for himself a broader conception of his calling, which deals with human as well as material problems.

It may be seen that no one of these three men neglects to place some emphasis upon the necessity of teaching the thought-process. No doubt the differences which show in their contributions are similar to the differences which the minds and personalities of these men would exhibit upon critical analysis. Each has described a method which is like himself and therefore successful in his hands.

But aside from and above these differences, a most interesting significance is definitely suggested in Professor Aydelotte's article and no doubt was present in the minds of the authors of the other two. Broadly considered, it is the dawning realization that engineers must be prepared in the schools to assume a more important position in society. The profession is definitely of the character of this industrial age and the position it is to assume, as well as the time of its arrival at that point, depends much upon the ability of its individual members to carry the burdens of the new order. And to this end nothing is more essential than that the engineer be able to meet with all men, and at all times and under every circumstance make himself understood.

Two Important Factors in Designing Sea-Water Concrete

THE articles on sea-water concrete in this and in the last issue tell the worst that Messrs. Wig and Ferguson have discovered in their long studies. Their remaining articles will outline improvements in methods and materials which help in fighting the sea-water attack, but even with these precautions it is their definite conclusion that plain concrete will succumb to chemical attack if its hardened surface is removed by mechanical means, and that reinforcement near the surface will sooner or later prove a source of cracking and decay.

The first of these conclusions is not one of novelty, but one of emphatic reiteration. The vulnerability of sea-water concrete in the intertidal space is well known, though the reasons therefor have not always been so plainly stated. In spite of this, much concrete continues to be built in places where mechanical abrasion is bound to take place, in the hope that superior materials and methods will serve to prevent disintegration. The Wig and Ferguson conclusions should reduce this practice. Their observations of practically all the sea-water concrete in this country show that methods or materials cannot be brought to such perfection as to guarantee against the chemical attack on an abraded surface. Some sort of physical protecting medium must be interposed between the concrete and the flotsam. This intertidal protection is quite easily provided. Furthermore, the concrete needing such protection can usually be readily repaired before serious injury occurs.

The cracking of reinforced-concrete structures by the rusting of the reinforcement, on the other hand, is a much more serious problem. Its occurrence is so wide, the causes leading to it so fundamental, the effect on the stability of the structure so serious, and the repair of damaged members so nearly impossible as to make a consideration of its danger of the utmost importance.

Unfortunately, the remedy for this trouble is not so obvious as for the intertidal wear. It seems certain that the common 2-in. protection is not sufficient, but just how much greater the protection must be is not certain. Other ways of preventing the rusting are noted in the article in this issue, but none is generally applicable. Until further studies disclose some better protective methods, the safest design for sea-water work, at least in concrete above the water line, will avoid reinforced members of slender dimensions and lightly embedded steel.

Judge Prouty's Valuation Views

APPARENTLY Charles A. Prouty, director of the Division of Valuation of the Interstate Commerce Commission, realizes that a fair valuation of the railroads cannot be based wholly on legal technicalities. The division's solicitor, P. J. Farrell, has filed with the commission a brief defending the division's treatment of the Texas Midland R.R., but Judge Prouty has supplemented this with an interesting memorandum on questions that "will not be controlled by ordinary legal considerations." In most respects he upholds the conclusions reached by the division, although his discussion in general shows that he has been not unmindful of the arguments and engineering testimony of the carriers. But in several respects he gives evidence of personal disagreement with the official stand of the division, and lends further support to a belief long held by this journal that with more broad-minded advisers he might be more liberal to the railroads.

Among the questions covered by Judge Prouty is the much discussed one as to whether or not an ultimate value shall be found. The carriers, or some of them, have been insistent that the Valuation Act calls for this figure, and that the division's work will be useless without it. The division has apparently decided otherwise, but the director believes that an ultimate value should be stated—"an ultimate value for ratemaking purposes." As he says, "the vice of the railroad situation today is uncertainty, and . . . some way must be found to assure capital of the treatment it will receive"—which he thinks cannot be done until value has been determined.

In lucid fashion the director sets forth his views on the conditions to be assumed in reproduction cost new; on what class of industry tracks shall be included and what class excluded from the valuation; on the proper construction period to assume, and on the allowances for engineering and for general expenditures. Much money is involved in some of these items, and in most cases the director does not fully agree with the carriers. Space is not available here for the discussion of all of these subjects, and most food for thought being found in his views on appreciation, depreciation, contingencies and land, attention will be confined to these.

Appreciation and Depreciation

There is no doubt in Judge Prouty's mind that appreciation of roadbed exists in an old railroad. But he sees neither how it can be computed nor how it can be accredited. Here we have him falling back upon the commission's accounting rules. According to them, appreciation costs the carriers nothing, as there is no appreciation account. So we have the familiar argument that this appreciation has been paid for out of operating expenses and should not be allowed—which in no way answers the carriers' contention that it is an element of real cost and that it matters not how it was paid for. But the director is open-minded enough to suggest that the commission may desire to recommit the matter to the division for further study.

In the matter of depreciation, as in that of appreciation, the director proceeds on the assumption that the carrier has been allowed to earn enough to cover the costs. If this were universally true it might be fair to deduct depreciation on the ground that the carrier "has somewhere, in some form, the amount of this depreciation." The gross unfairness of it is that whatever depreciation exists by the division's interpretation, in such a road, for example, as the Pennsylvania, existed long before there was recognition of the need for depreciation allowances, and that there is no evidence whatever that the 15% or so shrinkage has ever been paid back to the stockholders.

Contingencies

Prudent engineers must always include allowances of 5 or 10% for contingencies in the estimates of new work. This Judge Prouty freely concedes. He holds, however, that such contingencies are usually of two kinds. One embraces items that were not thought of in the estimate, but show in the completed structure and are therefore included in the valuation. The other covers more difficult materials or greater quantities than were anticipated—which would also show. But his classification of contingencies is only partly complete. Surely the carriers have brought out fully the effects of bad weather, floods, labor strikes and numerous other contingencies that increase costs without leaving any marks on the finished work.

Land

"It [the figure reported by the division as the present value of land; namely, market acreage value] is not the present value of the right-of-way of the carrier if that is to be determined either by what it would ordinarily cost the carrier to acquire a piece of that peculiar shape and for that use, or by the lessening of value to the entire tract of the landowner." This statement by Judge Prouty seems strong enough to condemn the division's method of determining present value. Unhappily he is not willing to go the whole distance and work out a bona-fide reproduction cost new for the land. He finds the Minnesota rate decision in the way of that, and so he justifies the substitution of the hybrid present value for reproduction cost by a discussion of statutory construction and its application to the Valuation Act. If present value by the Government's process turns out to be less than the original cost of the land he would investigate further and probably allow the actual cost; but otherwise he would accept the division's figure. He would not in any event put the Government to the expense of determining, as the carriers ask, the cost to condemn each parcel of land.

The carriers can blame themselves in part for the Government's attitude. Instead of arguing that the fault of the railroads' treatment of land in the Minnesota rate case was in the application and not in the principle, they admitted the fallacy of the principle, and then laboriously built up a process which in a roundabout way would produce the same results. And strangely enough the director holds that if something must be added to present acreage value to show cost of acquisition it should be by means of a multiple—the very thing that, so the carriers have all too readily admitted, damned them in the Minnesota case. And so they must get what solace they can from the evidence that Judge Prouty does not agree with Solicitor Farrell that reproduction cost of land is impossible and cannot be entertained.

The Catskill Aqueduct Builders

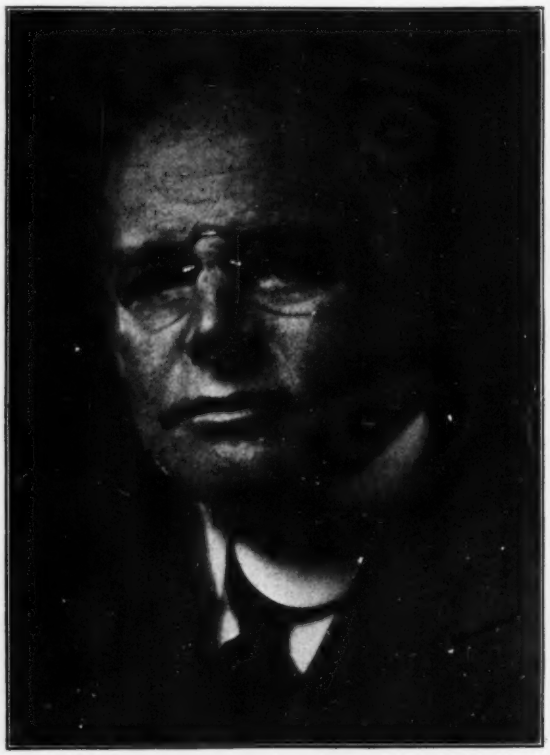
—*An Appreciation*

How J. Waldo Smith, Chief Engineer of the New York Board of Water Supply, Developed an Engineering Organization Noted for the Ability, Loyalty and Enthusiasm of Its Members

THIS WEEK will see the dedication of the Catskill Aqueduct, the formal recognition of the completion of the first installment of New York's $177,000,000 enterprise, by which 500,000,000 gal. of water can be brought to the city per day. For 12 years the aqueduct has engaged the interest of engineers. Much has been said about its massive structures; relatively little about the organization and the men who have carried the work to its successful conclusion. In the early days of the work there were announcements regarding the recruiting of the staff and the standards governing the selection of engineers. Later we heard about the "Chief's" dinners, at which J. Waldo Smith brought together his entire official family. Then, as the engineering bureau fell into its stride, the unusual character of the organization became apparent. Yet compared with the attention given to the works themselves, but little consideration has been given to the men back of the job.

In this article little is said about the work, much about the men and the organization.

Under the Inspiration of His Leadership as Chief Engineer, New York's $177,000,000 Catskill Water-Supply System Has Been Successfully Completed



J. WALDO SMITH

Any attempt to summarize briefly the accomplishments of the 12 years' labor of the engineering bureau of the Board of Water Supply would be unsatisfactory. Yet the complete picture must be kept in mind if we are to appreciate the achievements of the organization. Fortunately, the great structures have been described so often that their very names will help to bring up an impression of the magnitude of the enterprise. Among the great dams of the world now stand, as a result of the water board's work, the Ashokan and the Kensico. The Hudson River and the Narrows siphons are the only two of their kind, while the many miles of aqueduct—in tunnel, cut-and-cover and steel pipe siphon—are without precedent, capacity and length both considered, in water-works records. All of this work, involving an expenditure of millions, has been kept free from suspicion of the honesty of anyone connected with it, and from ugly controversy about the capability of the designers or the quality of the work; and this in a city where political contests have been fought bitterly, and where many efficient heads have been removed because principles were upheld. The engineering bureau has kept out the inefficient; has successfully resisted the onslaughts of those who might have sought improper advantage, and has given to the city a set of structures which experts have pronounced excellent in the highest degree.

It is patent that only an extraordinary organization could have produced so splendid a result. That organization could be diagrammed and one might say, "This is the machine that did the work," but such praise would be inadequate. We propose, therefore, to inquire into the factors that enter into the organization; into the spirit which made it so effective that in 12 years, without friction or just criticism, it brought the great Catskill work to completion.

It is apparent to anyone who comes in contact with it that the organization has a remarkable personnel. There is a distinctiveness about Board of Water Supply men. They are cleancut men, first-class engineers, each in his special place; thoroughly loyal to the organization; "regular fellows," men whom one is glad to know and meet, men on whom one can rely for help, men who are so able that each adds to the impression that they compose a wonderful team, fully competent to grapple with any problem, whether of design or construction. And yet their self-confidence includes nothing of insolence or "cocksureness," but just the reliance upon his own power of the strong man who has tried his strength, knows how to use it and has a right to feel that within his own field none can challenge his mastery. This confidence is reflected in the quality of the work performed.

What the men are, so is the organization. They were selected because they conformed to the organization type, to the high standard which J. Waldo Smith set when he started on the task of recruiting his staff. The men he wanted had to be good engineers, thorough in their work, so that no factor would be neglected in design or construction. They had to be able to work well with others. They had to be capable of enthusiasm, of throwing themselves wholeheartedly into their jobs. They had, in addition, to be gentlemen, for only where there is consideration for failings and feelings of others can there be consistent teamwork.

If an epitome were asked of the characteristics of the men of the organization that built the Catskill system, probably the foregoing description would be found to be accurate. It certainly sets forth the impression which the board's engineers have made on those who have met the men of the organization during the 12 years of its life.

But that description is necessarily a generalization. It is necessary to ask, How did these characteristics show in detail in the day's work? How was the staff recruited? How, when obtained, was it held together? How was teamwork promoted? Who was the builder of this human structure and what manner of man is he?

The Chief Engineer

The New York Board of Water Supply was organized in June, 1905, and at once selected J. Waldo Smith as its chief engineer. He had had long experience in water-supply work and had displayed exceptional organizing and executive ability as chief engineer of the Jersey City water-supply system, which, including the Boonton reservoir and a long aqueduct, bears resemblance, though on a smaller scale, to the Catskill scheme. The board's choice was fortunate, not only because of the chief's ability, but because he won quickly the absolute confidence of the board, a confidence that has never wavered. That confidence was an essential foundation not only for ultimate success but for the chief's first task, that of recruiting the men with whose aid the work was to be done.

Sensible of the magnitude and intricacy of the task, Mr. Smith saw that none but a superlatively good organization could succeed. He therefore selected with the greatest of care the nucleus of his staff, the men whom he expected to assume the major responsibilities and become his department heads. Not only did their technical attainments have to be high, but their views as to organization building had to agree with those of the chief. Upon these men he depended, in large part at least, for the selection of the other members of the engineering bureau. These men—seven in number, including the deputy chief engineer, the division engineers, engineers in charge of designing and the consulting engineers—were exempt from civil-service rules. All of the other members of the organization, however, were subject to civil service competitive regulations. This makes the story more interesting and the lesson more valuable.

Recruiting the Staff

How was a staff of the high grade desired by the chief engineer to be recruited, when civil service might admit undesirables and exclude able men who had a horror of examinations? The law had to be observed; there was no thought of trying to evade it. Accepting the situation and studying carefully its possibilities, Mr. Smith and his associates found the law an aid instead of a hindrance. It was found on study to be flexible enough to bring in the right men, and strengthened the corps against outside influence, once the men were selected.

In choosing men, merit and fitness can be determined better, of course, by personal interview than by written examination. Character, temperament, executive ability and similar qualifications cannot be measured by written tests. To be sure of getting a good staff even through civil service procedure, the board (1) encouraged men of the right class to take the examinations; (2) saw to it that the scope of each examination covered properly the qualifications needed for each position; (3) exercised fully the privilege of selection allowable under the rules and the right of dismissal without charges or without other reason being assigned than that an individual had proved unsatisfactory during a probationary period. Besides encouraging capable men to take the examinations, Mr. Smith induced the board to fix a salary scale high enough to attract the best men in the profession. It is commonly said that the board's force was the best-paid engineering organization in the country. Mr. Smith wanted superior men and he was willing to offer salary inducements to get them. The results demonstrated the value of this policy. Board of Water Supply salaries, however, have not been excessive in comparison with others. Indeed, in individual cases and in averages of some classes, higher salaries have been paid in some other forces. Board of Water Supply pay, however, has been "good," although not a few men have left the work because of higher offers.

Among the definite standards set in selecting employees was one calling for men of medium age. Such men, with the right kind of experience, have ability to advance. The matter of age was deemed especially important in the selection of those who might be developed into heads of departments, divisions and sections. Men of medium age will not only do work of higher excellence than older men, but will do it with enthusiasm. Their ambition will be stimulated by knowledge that higher positions will be filled by promotion.

Holding the Men

The men having been obtained, a greater task—to hold them and to weld them into an effective organization—was encountered. Description of the method of holding the men is difficult, because there were so many influencing factors. Congenial character of the whole organization was an important desideratum. Another element of the problem was the fact that the job was the greatest of water-works enterprises, and it was necessary to place responsibility upon a man so that he could show what he could do.

Certain definite policies, however, acted directly to hold good men in the organization. Higher positions, when the preliminary organization was effected, were always filled by promotion, the examinations for the

higher places being restricted to members of the staff. Changes came at intervals, too, for the force expanded rapidly, particularly when construction was started, while good men on the staff received constantly offers of positions of high responsibility outside of the work. The staff knew well that the "Chief" would obstruct no one's acceptance of an outside offer, but rather that he would help to place a qualified man if the proferred place offered a larger opportunity. These causes for change of personnel, in addition to deaths and normal departures, afforded the members of the staff opportunities for steady progress upward.

Again, it was known that if a man of good parts failed to fit where first placed, he would be tried at other work in order to put him in a position advantageous to the work and to himself. Change of place or of work was also made if a good man began to grow "stale." So long as a man's interest is kept up he is not likely to become dissatisfied.

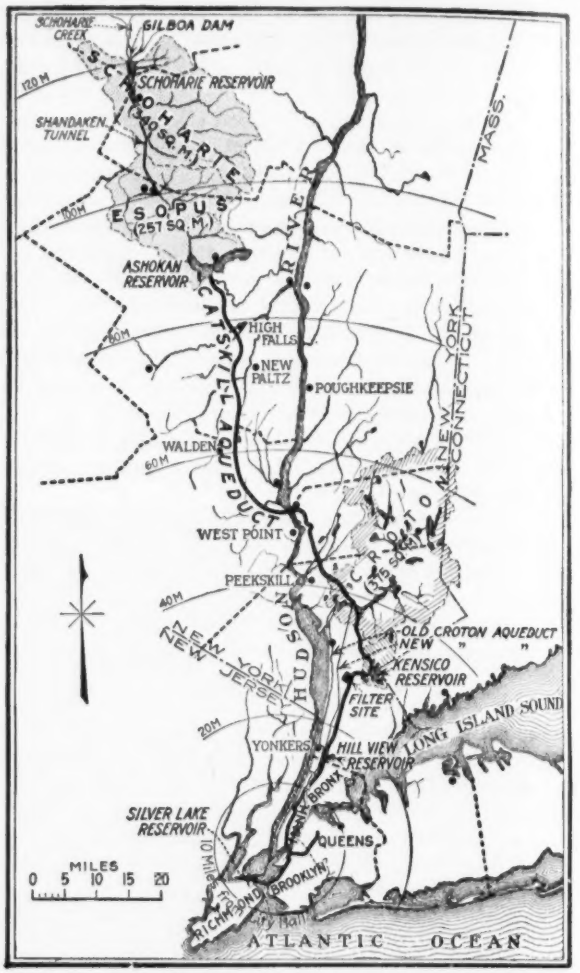
A cardinal principle of the management was that men should be encouraged to take responsibility. This was well expressed by Mr. Smith himself in these words: "Every effort should be made to encourage the taking of responsibility and to train the men so that they will be capable of advancement when the opportunity comes. You never know what a man will do until the responsibility is pushed on him, but generally he will do far better than was thought."

Added to these loyalty-inculcating policies were the convictions that the "Chief" was determined to keep a force fully equal to the huge task, and that he would stand by his men and fight for them should the board at any time, by salary ruling or otherwise, do or attempt to do anything inimical to the organization or to deserving individuals.

Of course, such policies, while tending strongly to hold the men, were not followed for the mere purpose of keeping a full force. Rather, their adoption was due to the conviction that fairness to the men and the best interests of the work demanded them.

TEAMWORK

In the task of developing teamwork the chief engineer was no less successful than in the selection and holding of men. In fact, his accomplishments in teamwork were especially noteworthy. Teamwork was invaluable on a job of this kind, where so much was unprecedented, the variety of work was so great, the extent of territory covered so large. Everything was done to promote acquaintanceship and mutual interest in all parts of the work. Headquarters had personal acquaintance with the man on the section, while the field man visualized the individual in the New York office with whom he dealt and with whose help he was trying to solve his knotty problems. A bi-weekly paper, the *Catskill Aqueduct News*, helped to keep everybody informed about the latest happenings on the job, the changes of position or station, the status of contracts, striking features proposed or completed, etc. Department dinners, field days, bowling tournaments, baseball games, etc., helped to bring the men together in friendly intercourse, while on several occasions Mr. Smith gathered the whole force in New York at big dinners.



THE CATSKILL ENGINEERING ORGANIZATION EXTENDED OVER A 100-MILE LINE OF WORK

The consequence was that the whole staff—approximately 1000 during the busiest years—grew into a large family. Everyone knew he had a part in a huge undertaking and gave his best to make the work a success. Beside him were others working with the same spirit, while on top was a man who was interested in their welfare, who treated them as men and not as parts of a machine, who was glad to have a word with them on his frequent visits to the field, to make suggestions and commend work well done. What wonder, then, that the force was loyal and enthusiastic, or that the big job was well done.

But that fine spirit did not end with enthusiasm for the "Chief," the organization and the job. It led every man to feel that as a member of the family he could offer suggestions freely regarding any detail of the work. Conferences, encouraged by the chief and the department heads, were frequent and were entered into with the best of spirit. Opposing views were advanced with the best interests of the work in mind and were discarded or modified as the good of the project required.

Those in responsible positions promoted teamwork by seeing to it that a man confronted with a difficult problem got all the help he needed. A method of man-

agement—or mismanagement—frequently observed is when the "boss" assigns a job to a man and then feels that he has "gotten out from under" the responsibility, leaving the subordinate to sink or swim. The modern view of management requires the "boss" to know more about the job than the subordinate and makes it his duty to see that the employee does his work in the best way. The Water Board followed that policy.

That good fellowship prevailed in the organization does not mean that there was lack of discipline or that authority was not well defined. But the spirit that obtained obviated any need of harsh disciplinary measures. When conflicting plans were proposed discussion on them was free, but when the decision was made, it was the rule of the organization for everyone to fall in line behind it.

Troublesome men, when they made their propensities known, were quickly dismissed. So also were those who were inclined to exaggerate their usefulness or to be displeased with the amount of recognition which they received. Thus high ideals regarding the personnel were maintained.

THOROUGHNESS

An earlier paragraph mentioned the great stress that was placed on the need for thoroughness on the part of all employees. The men of the organization accepted and appreciated the responsibility. They were building a conduit upon which depended the health and welfare of a city with a population rapidly exceeding 5,000,000. The structure is to last indefinitely. Almost $200,000,000 was entrusted to the staff for expenditure. Under such conditions only the best work could satisfy. To insure the municipality getting the best, the organization drew freely on outside advice. The engineers called in were selected for breadth of experience and eminence in the profession, or for unusual knowledge and skill in specialties. A few have been attached continuously to the staff, while others have had brief engagements, depending upon the needs of the work. The group has included a few of the older men, the deans, and with them specialists in filtration and other methods of treating water, mechanical and electrical experts, sanitarians, railroad engineers, geologists, metallurgists, architects and landscape engineers. Among these consultants, to mention only a few, were the late Alfred Noble, Allen Hazen, George W. Fuller, John R. Freeman, Frederic P. Stearns, Prof. James F. Kemp, C. P. Berkey, geologists; Charles W. Leavitt, landscape engineer; York & Sawyer, architects.

In line with the determination to leave no resource untouched to obtain the best solutions of the problems encountered, the engineering bureau instituted many important original investigations in its laboratory. But its delving to the bottom of things engineering, in the search for solutions of its problems, did not stop there. It was realized that the best replies to many knotty questions could be obtained only by experiment on full-sized models, many of which were built. Each helped to point the way to an advance. The construction of trial sections of the cut-and-cover aqueduct and of reinforced-concrete pipe siphon are examples. The unusually extensive borings and geological explorations made before construction also fell in the same class and dispelled many a doubt as to conditions which otherwise would have remained unknown until difficulties were encountered as construction progressed. In this way the contract risks were lessened, and the thoroughness of the investigations was undoubtedly reflected in the prices bid on the work.

TRIBUTE

From the Chief Engineer to his Engineering Staff

NO great construction undertaking can be carried to a successful completion because of the genius or personality of any one man, although the people are prone to hero worship and to give the credit to some one person when it always rightfully belongs to many. This is particularly true of the work of designing and constructing the Catskill water-supply for the City of New York. Whatever success has been attained has been due to the spirit which permeated the organization and to the varied talents, ability and energy of the individuals composing it.

The organization has been an asssociation of individuals whose character, discipline and breadth of vision, as well as loyalty and devotion to duty, have not been excelled. Jealousy and envy, the roots of all trouble, were cast into the discard at the outset, and in their place came consideration for each other and a merging of personal interests in those of the job. The magnitude of the work and the fact that it was to provide what is as necessary to the life of this great city as the very air it breaths, and without which it cannot increase in numbers, power or wealth, served as an inspiration to a class of men who are guided by ideals and who work for accomplishment more than for money or glory.

The entire underlying spirit was one of belief in one another and of mutual consideration. This feeling extended to all connected in any way with the work, contractors, manufacturers, laborers, and combined with it was a spirit of helpfulness that worked for efficiency, economy and progress. Close association with men of this type for twelve years has brought great joy and happiness, has made life more worth living and has furnished a stock of reminiscences which will cheer the years to come.

It is hoped that every one who has been connected with the work may look back on those years as the happiest of their lives, and that they have acquired an experience which will bring advancement and honor. Credit for the success of the undertaking rests with each and every individual who steadfastly, earnestly and loyally gave of his talents toward this accomplishment. If recognition does not come in any other way, the consciousness of a service well and fearlessly performed is of itself worth while and brings with it a satisfaction which nothing can take away.

In the years of the future the people of the City of New York will come to understand better than they do today the unselfish nature of the work which has been accomplished by this organization. That they now understand it somewhat is evidenced by this great celebration which is now in progress, but not one of them now, or ever, will understand as I do the sacrifices made and the unselfish devotion given in helping the undertaking to its conclusion. I realize, too, and feel more keenly than any one else, that whatever honor has come to me personally has come as the result of individual effort, endeavor and loyalty on the part of every member of the organization, of which it was merely my fortune to be the head. Without them and their wholehearted support, success could not have been achieved.

J. WALDO SMITH.

Moreover, as a result of a ruling by the law department of the city that none of the contracts could contain a clause covering the doing of unusual or unanticipated work, commonly known as an "extra work clause," it was necessary to prepare each contract with far more than the usual care. Every contingency had to be provided for, and that the entire work was completed under the original contracts was due to the thorough investigations and explorations which were made whenever there existed the least doubt as to the conditions which might be met.

It would not be fitting to close this description of the Catskill engineering organization without a further word regarding the man at its head—the man to whom the spirit which has animated the staff is attributable. At the root of his success lies love for his fellow men. He likes people. He wants to help them, to see them get ahead, to give them full credit for what they do. Despite the fact that dozens of articles describing the work have been written by the staff, and many lectures have been delivered, not once has Mr. Smith written an article, and rarely has he delivered a lecture. He was glad to have his co-workers do this and get the credit.

As he himself has said, "Everyone has his own way of handling an organization." Mr. Smith's way is to work in an atmosphere of good fellowship, to live on close, almost familiar, terms with his men, yet to do it without relaxing discipline or departing one iota from the utmost thoroughness in both design and construction. Simple and unaffected, he went about on the big job, always with a word of helpful suggestion, inspiring all not by enthusiastic outbursts or long speeches but by his poise and the apparent confidence he reposed in the members of the organization. "Not one of the men connected with the job but regrets the passing of the aqueduct days," said one of the men recently, and he added that the contractors, held to the mark but treated fairly, felt the same way.

The undertaking was carried out in an atmosphere of sunshine engendered by individual realization of the humanitarian attitude of those charged with its execution. But the atmosphere was tempered by the winds of accuracy and of thoroughness, and the tang that made for high efficiency came from the realization, emanating from the chief engineer himself, that nothing counts but progress and that there is no real joy save in accomplishment. His motto was, "Get the work done, but get it done well."

Iron-Removal Plants in New Jersey

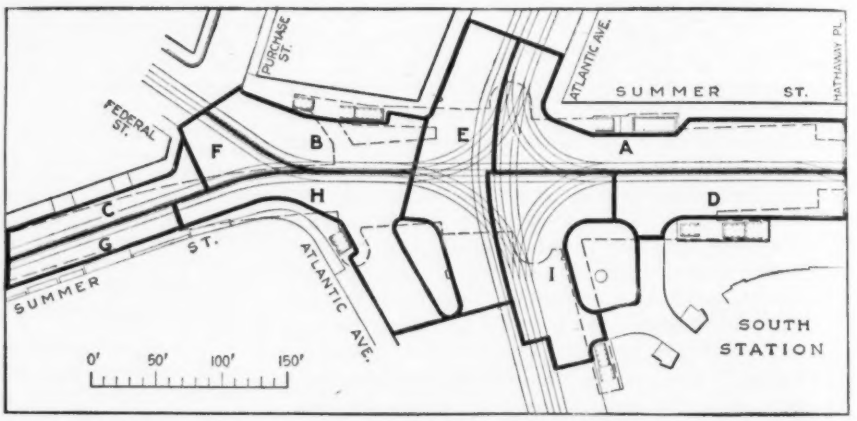
There are 23 plants for removing iron from public water-supplies in New Jersey, according to the latest report of the New Jersey State Department of Health.

Grouted Granite Block Laid Under Congested Traffic Conditions

Paving of Dewey Square, Boston, in Front of the World's Busiest Railway Terminal, Presents Special Problems

EVERY kind of traffic is met with at the intersection of Federal and Summer Sts. and Atlantic Ave., Boston, Mass.—a marginal waterfront freight railway on Atlantic Ave., double-track intersecting street railways, trucks and vehicles of all descriptions, and pedestrians passing to and from one of the busiest railway passenger terminals in the world. Overhead is the elevated structure on Atlantic Ave., and below the new subway in Summer Street.

These great streams of traffic, it was decided, should be maintained as nearly as practicable without interruption—while the paving of Dewey Square was carried on in limited areas, traffic using the other portions. The street-car service was maintained on all the tracks



BLOCKING OUT GRANITE-BLOCK PAVING JOB TO MAINTAIN TRAFFIC

except at night and on Sundays, during which periods the sections of track were removed and graded.

The plan herewith shows the method of procedure. While sections *A*, *B* and *C* were being constructed traffic was maintained in the other areas. When section *A* was completed and opened for traffic, sections *D* and *E* were closed and construction was begun in them. When section *B* was opened for traffic, section *F* was closed. When section *C* was finished section *G* was closed. After sections *C*, *F*, *B* and *E* were completed, section *H* was closed. After section *E* was opened to traffic, section *I* was closed. As soon as sections *D*, *H*, *G* and *I* were completed they were opened for traffic.

The railway companies graded and ballasted their tracks with broken stone ballast, the paving contractor doing the necessary excavation. This trackwork was all done between the hours of 8 p.m. and 7 a.m., and on Sundays. When the tracks had been relaid and ballasted, car traffic was continued for three days, or sufficient time for the track to become rigid. The ballast was then filled with a 1:2½ cement grout by the paving contractor, then the 6-in. concrete base was placed, after which the paving blocks in the space between the rails were laid on a 1-in. sand-cement bed and the joints grouted as soon as possible with a 1:1

THE PROBLEM OF PAVING AND MAINTAINING TRAFFIC AT DEWEY SQUARE, IN FRONT OF SOUTH STATION, BOSTON, WAS A COMPLICATED ONE

sand-cement grout. The grouting of the ballast and the laying of the pavement in the track areas was done almost wholly during the daytime between car movements.

During the three days that the tracks were being regraded and settling on their new ballast, the contractor excavated the adjoining area between the rail and curb, rolled the sub-grade and laid the concrete base. The paving of this area followed closely the paving of the track, and no section of the street was closed to traffic for more than about a week, except the time allowed for the grouted joints to set—about a week. Paving the tracks of the Union Freight R.R. was simpler, the only condition being that the running of trains was not to be interfered with between the hours of 8:30 and 9:45 p.m. and 1:30 and 6 a.m.

Standard Specifications Followed

The contractor was required to maintain at all times a safe roadway on one side of each street and from intersecting streets into Summer St. and Dewey Square. When necessary temporary granite paving was laid with gravel joints, for which the contractor received 50c. per square yard.

The pavement was laid under the standard specifications of the City of Boston and forms the final surfacing of the street after the construction of the Dorchester tunnel. It replaces the temporary paving which was laid on 8 ft. of filling over the tunnel roof, directly following the placing of the backfilling (in 1915). Since the new pavement is a better one than was on the street when the subway work in this locality began, the City of Boston and the Boston Elevated Railway Co. are paying the additional part of the cost. The contract price was $4.43 per sq.yd., divided as follows: $3.57 for furnishing and laying the blocks, including excavation of the sub-grade and grouting the joints; 20c. for the sand-cement bed; 91c. for the 6-in. concrete foundation and a credit of 25c. per sq.yd. for the old blocks. For grouting the ballast of the street railway tracks, the price paid was $9.75 per cu.yd. of grout.

The work was done under the direction of the Boston Transit Commission as a part of the construction of the Dorchester tunnel. William W. Lewis, assistant engineer was in charge of the work, and Henry S. Clark was the contractor. The granite blocks were furnished by the Rockport Granite Co., Rockport, Mass.

States Spent $288,000,000 on Roads and Bridges in 1916

U. S. Office of Public Roads Issues Figures Showing Total Mileage of 2,455,761 for Rural Routes

CASH expenditures on the rural roads and bridges in the United States in 1916 amounted to $272,634,424, according to figures just published by the Division of Economics, U. S. Office of Public Roads and Rural Engineering. To this should be added the value of the statute and convict labor, which can not be fixed with any great degree of accuracy, but probably amounted to not less than $15,000,000, thus making the grand total expenditure for the year $288,000,000. This total is made up of the actual expenditure for such items as labor, materials, supervision, management, and administration directly connected with the construction, improvement, and upkeep of our public roads and bridges.

This, however, does not represent the total outlay by the states and communities because of their rural public roads. At present there are outstanding more than $400,000,000 of road and bridge bonds and long-term warrants, maturing at the rate of about $20,000,000 per year and requiring about an equal amount for the payment of interest charges.

The Bond Situation

The full extent of this bond burden, however, is impossible of any exact determination. More than $40,000,000 of new road and bridge bonds are now being issued annually. Furthermore, general bonds are issued in many cases to cover actual or threatened deficits occasioned wholly or in part by the road and bridge expenditures. Outstanding road or bridge bonds or warrants often are taken up by general refunding bonds and the identity of the bonds as pertaining to road work is thus lost. "Such data as are available," says the Office of Public Roads circular, "serve forcefully to call attention to the abuses to which the bond method of financing often is being subjected. To issue bonds for the financing of road improvements frequently is both advisable and necessary. But this does not justify some of the present-day practice. Millions of dollars' worth of road bonds having a term of 30 years or more still are being issued every year, and one state has gone so far as to legalize and encourage the use of bonds having a term of 41 years for the financing of local road construction. This all too frequent practice of issuing long-term bonds in payment of improvements which can not possibly last one-half of the term of the indebtedness can be defended neither on the grounds of sound public policy nor of good business. It should be discontinued at once."

From 1904 to 1915, inclusive, the annual increase in the expenditures on rural roads and bridges amounted to approximately 12% over each preceding year. The increase of 1916 over that of 1915, however, was only 2%. This was due largely to the scarcity of labor and materials which caused an unusually large number of contracts to be carried over to this year. In New York State alone, contracts involving about 900

TABLE I. EXPENDITURES DURING THE YEAR 1916 BY OR UNDER THE SUPERVISION OF THE STATE HIGHWAY DEPARTMENTS

State	Funds			Distribution of Expenditures						State Funds Available 1917 (approximate)	Local Road and Bridge Expenditures, 1916, not under State Highway Department (approximate)
	State	Local	Total	Construction Roads	Construction Bridges	Maintenance, Roads and Bridges	Engineering	Administration	Equipment and Miscellaneous		
Alabama	$102,422	$83,962	$186,384 00	$157,257	$12,747	.....	$7,150	$9,230	.....	$200,000	$4,000,000
Arizona	441,202	.....	441,202 17	246,366	114,549	$28,130	26,976	14,712	$10,469	600,000	1,547,019
Arkansas	55,483	[1] 1,683,549	1,739,032 00	1,683,549	[2]	.....	30,894	24,589	.....	300,000	1,704,855
California [13]	4,285,964	.....	4,285,964 43	2,766,910	.....	1,033,564	298,153	[3]	187,337	6,000,000	16,106,470
Colorado	607,628	662,829	1,270,456 59	851,970	[4] 245,610	126,110	[12]	46,767	.....	750,000	1,042,751
Connecticut	1,865,948	85,000	1,950,947 83	377,574	151,469	1,315,028	79,713	19,756	7,407	2,000,000	1,250,000
Delaware	31,000	31,000	62,000 00	60,000	.....	.....	.....	2,000	.....	200,000	450,000
Florida [7]	10,484	.....	10,483 70	.....	.....	.....	3,637	5,519	1,328	20,000	4,000,000
Georgia [6]	.....	.....	.....	.....	.....	.....	.....	.....	.....	[8]	3,750,000
Idaho	100,057	348,061	448,118 00	281,956	92,072	27,534	33,976	6,080	6,500	750,000	1,500,000
Illinois	1,119,202	1,593,953	2,713,154 48	1,830,855	587,336	33,763	171,826	53,620	35,755	1,500,000	7,643,515
Indiana [5]	.....	.....	.....	.....	.....	.....	.....	.....	.....	400,000	13,500,000
Iowa [6]	90,821	.....	90,821 00	.....	.....	.....	90,821	[9]	.....	200,000	14,337,056
Kansas [7]	10,000	.....	10,000 00	.....	.....	.....	[12]	10,000	.....	[8]	5,600,000
Kentucky	708,346	1,740,187	2,448,533 00	2,357,721	[2]	.....	64,292	26,540	.....	750,000	2,000,000
Louisiana	184,533	274,111	458,643 30	401,599	.....	14,768	21,828	18,803	1,646	200,000	3,000,000
Maine	1,055,250	453,518	1,508,768 29	1,034,340	80,519	292,406	62,197	37,402	1,905	1,000,000	1,658,447
Maryland	2,280,000	280,000	2,560,000 00	1,500,000	300,000	650,000	70,000	30,000	10,000	1,500,000	3,000,000
Massachusetts	2,701,236	447,905	3,149,141 30	1,620,647	.....	1,212,041	200,422	57,485	58,546	3,950,000	3,350,000
Michigan	982,939	2,350,000	3,332,939 00	3,100,000	[4] 101,176	[10] 32,169	56,738	30,849	12,007	1,500,000	6,750,000
Minnesota	1,390,525	3,376,550	4,767,075 79	2,865,381	[4] 891,353	793,254	217,088	[9]	.....	1,500,000	3,975,192
Mississippi [7]	6,500	.....	6,500 00	.....	.....	.....	[12]	6,500	.....	10,000	3,250,000
Missouri	482,860	[9]	482,859 99	279,548	.....	193,226	.....	10,085	.....	700,000	7,500,000
Montana [7]	26,150	.....	26,150 06	.....	.....	.....	6,589	13,539	6,023	150,000	3,449,419
Nebraska	110,000	90,000	200,000 00	.....	180,000	.....	6,500	13,500	.....	500,000	4,300,000
Nevada [5]	.....	.....	.....	.....	.....	.....	.....	.....	.....	140,000	275,000
New Hampshire	414,669	430,742	845,410 48	481,512	24,473	284,224	30,853	21,039	3,300	450,000	1,200,000
New Jersey	1,167,843	2,616,511	3,784,353 61	673,845	256,350	2,449,158	150,000	130,000	125,000	2,000,000	2,000,000
New Mexico [11]	385,684	43,267	428,951 88	398,952	[2]	.....	20,000	10,000	.....	400,000	400,000
New York	9,409,655	2,441,225	11,850,880 37	6,025,944	.....	4,252,397	1,257,666	247,358	67,515	12,000,000	[19] 8,050,510
North Carolina [7]	10,000	.....	10,000 00	.....	.....	.....	[12]	10,000	.....	10,000	5,500,000
North Dakota [7]	.....	.....	.....	.....	.....	.....	.....	.....	.....	200,000	2,711,295
Ohio	2,885,071	3,107,554	5,992,624 83	4,836,404	.....	748,778	266,464	137,741	3,248	3,800,000	7,000,000
Oklahoma	300,000	1,825,000	2,125,000 00	936,000	650,000	330,000	68,000	6,000	135,000	300,000	1,500,000
Oregon	165,662	290,000	455,661 87	151,091	290,000	.....	7,327	7,244	.....	500,000	5,500,000
Pennsylvania	3,663,352	322,040	[14] 3,985,392 39	478,445	53,951	2,907,498	193,817	199,823	[18] 151,880	8,000,000	7,000,000
Rhode Island	543,152	.....	543,151 69	.....	57,199	439,052	37,503	6,430	2,968	700,000	400,000
South Carolina [5]	.....	.....	.....	.....	.....	.....	.....	.....	.....	30,000	1,250,000
South Dakota [7]	.....	.....	.....	.....	.....	.....	.....	.....	.....	[8]	2,708,000
Tennessee	200,000	400,000	600,000 00	350,000	25,000	170,000	30,000	25,000	.....	750,000	4,000,000
Texas [5]	.....	.....	.....	.....	.....	.....	.....	.....	.....	500,000	10,500,000
Utah	179,400	725,760	905,160 00	607,700	88,130	96,310	[16]	11,300	101,720	560,000	950,000
Vermont	632,800	250,000	882,800 00	454,200	44,000	340,000	9,600	35,000	.....	500,000	725,000
Virginia	542,524	1,348,725	1,891,248 75	1,586,874	163,679	[17] 48,922	69,638	22,136	.....	800,000	1,800,000
Washington	859,672	2,104,340	2,964,012 71	2,442,158	[2]	424,529	67,037	30,288	.....	2,000,000	4,554,330
West Virginia	10,967	.....	10,967 41	.....	.....	.....	[15]	10,967	.....	200,000	5,500,000
Wisconsin	950,000	4,120,764	5,070,764 00	3,631,026	1,004,738	210,000	[15]	225,000	.....	1,500,000	5,500,000
Wyoming [5]	.....	.....	.....	.....	.....	.....	.....	.....	.....	50,000	450,000
Total and average	40,969,001	33,526,553	74,495,554 29	44,469,824	[18] 5,414,331	18,452,861	[18] 3,656,705	[18] 1,572,292	929,554	60,010,000	198,138,859

[1] Local bond issues by highway districts.
[2] Included under roads.
[3] Included under engineering.
[4] Includes culverts.
[5] State highway department established in 1917.
[6] General supervision of all highway work.
[7] State highway department educational and advisory.
[8] No data.
[9] On trunk line roads only.
[10] State reward funds to counties.
[11] Approximate, exact data not available.
[12] Includes $1,990,575 State aid to towns.
[13] Engineering included under administration.
[14] Does not include $712,500.93 paid as cash bonus to second-class townships.
[15] Includes $80,246.90 paid for purchase of toll roads.
[16] Included under construction.
[17] Includes $13,592.37 for 14.77 miles of surface treatment.
[18] Partial totals.
[19] Does not include $168,026 expended by the State department of engineering in improving 72 miles and maintaining 561 miles of mountain road.

miles of state and county highways were left uncompleted at the close of 1916.

The movement for state-aid and more centralized control in the management of public roads which first received definite status with the passage of the New Jersey state-aid bill in 1891, and has been practically continuous ever since, received a further impetus and still wider recognition in 1916 with the passage of the Federal-aid road act, approved July 11. This act authorizes the Secretary of Agriculture to coöperate with the states, through their respective state highway departments, in the construction of rural post roads. The particular roads to be improved are selected by the state highway department of each state and approved by the Secretary of Agriculture.

For carrying out the provisions of this act, Congress appropriated $75,000,000, of which $5,000,000 is made available for the fiscal year 1917, and a sum increasing annually by $5,000,000 for each of the following years until 1921, when $25,000,000 will be available. Three per cent. of the appropriation is available for administration and overhead expenses, and the remainder is apportioned to the several states on the basis of population, area, and mileage of rural-delivery routes and star routes, each having a weight of one-third. The state must pay at least one-half of the cost of all the roads improved from Federal-aid, and in addition, it, or its civil subdivisions according to its laws, must maintain these roads after they are constructed. Under the same act $1,000,000 a year for 10 years is appropriated for the construction and maintenance of roads and trails in or partly within the national forests, in coöperation with the state, territory, or county, upon a basis equitable to both parties. This Federal participation already has resulted in a marked activity on the part of the states, until at the present time every state in the Union has succeeded in establishing some form of state highway department.

The public rural roads of the United States at present have a total length of 2,455,761 miles, of which about 287,000 miles, or 11.6%, are improved with some form of surfacing. The mileage of hard-surfaced roads is increasing at the rate of about 15,000 miles per annum. During 1916 the states having state highway departments surfaced about 7000 miles under state supervision and also improved an additional 9000 miles by grading or otherwise. Thus, of the really constructive work of permanent improvement in the United States last year, about one-half was more or less directly under competent state supervision. In addition to this work of construction the several state highway departments also supervised the maintenance of 75,811 miles of main and trunk-line highways.

What the Tables Show

The expenditures in 1916 by or under the various state highway departments are shown in Table I, and the work accomplished is shown in Table II. Table III shows the expenditure of state and local funds for the years 1914 and 1916.

TABLE II. ROAD MILEAGE

State	Work done in 1916 under State Supervision: State and state-aid roads built in 1916	Roads maintained with state-aid, 1916	No. of bridges built by state or state-aid, 1916	Mileage of Rural Public Roads: Total state and state-aid roads built to Jan. 1, 1917	Total all surfaced roads in state (approx.)	Total all public rural roads in state	% of surfaced roads in state
	Miles	Miles		Miles	Miles	Miles	
Alabama	[3] 82		4	659	6,000	55,446	10.8
Arizona	70	214	([6])	372	375	12,075	3.1
Arkansas	[7] 380	.....	.....	534	1,500	50,743	3.0
California	256	1,153	.....	1,907	12,300	61,039	20.2
Colorado	[10] 2,105	2,603	170	[9] 7,305	1,800	39,780	4.6
Connecticut	[8] 56	1,432	9	[4] 1,627	3,100	14,061	22.0
Delaware	6	.....	.....	160	275	3,674	8.0
Florida	.....	.....	.....	.....	3,500	17,995	19.4
Georgia	.....	.....	.....	.....	13,000	80,669	15.3
Idaho	[11] 120	380	60	413	800	24,396	3.3
Illinois	[12] 299	278	449	767	12,400	95,647	13.0
Indiana	.....	.....	.....	.....	31,000	73,347	42.5
Iowa	.....	.....	.....	.....	1,000	104,074	1.0
Kansas	.....	.....	.....	.....	1,400	111,052	1.3
Kentucky	[13] 811	.....	.....	1,611	13,400	57,916	23.2
Louisiana	[14] 160	355	.....	752	2,400	24,563	9.8
Maine	[15] 229	3,402	11	1,798	3,250	23,537	13.8
Maryland	95	1,450	12	1,321	2,900	16,459	17.6
Massachusetts	[16] 192	1,100	([19])	1,998	8,900	18,681	47.6
Michigan	743	3,000	19	3,940	9,600	74,190	13.0
Minnesota	[18] 3,769	12,704	[17] 192	10,011	6,500	93,517	7.0
Mississippi	.....	.....	.....	.....	2,600	45,779	5.7
Missouri	([19])	9,000	.....	([19])	7,250	96,041	7.6
Montana	30	.....	127	30	800	39,204	2.0
Nebraska	.....	.....	7	.....	1,350	80,272	1.7
Nevada	.....	.....	.....	.....	320	12,182	2.6
New Hampshire	104	1,150	3	1,280	1,900	14,020	13.5
New Jersey	70	2,429	14	2,054	6,000	14,817	40.5
New Mexico	[20] 315	.....	74	846	550	11,873	4.6
New York	515	6,500	.....	6,765	18,000	79,398	22.7
North Carolina	.....	.....	.....	.....	6,750	50,758	13.3
North Dakota	.....	.....	.....	.....	1,100	68,796	1.6
Ohio	371	1,445	227	1,299	31,500	86,354	36.5
Oklahoma	1,900	[22] 7,000	[21] 2,100	1,900	300	107,916	0.3
Oregon	39	.....	22	413	4,875	36,819	13.2
Pennsylvania	[24] 248	9,171	24	1,988	10,500	91,556	11.4
Rhode Island	.....	305	4	325	750	2,170	34.5
South Carolina	.....	.....	.....	.....	3,700	42,226	8.8
South Dakota	.....	.....	.....	.....	750	96,306	0.8
Tennessee	150	500	7	150	8,750	46,050	18.9
Texas	.....	.....	.....	.....	12,000	128,960	9.3
Utah	[2] 586	3,440	[5] 36	3,440	1,500	8,810	17.1
Vermont	180	4,200	67	2,011	2,100	14,249	14.9
Virginia	[25] 700	.....	67	4,463	5,500	53,388	10.3
Washington	[26] 420	2,100	.....	1,977	5,900	42,428	13.9
West Virginia	.....	.....	.....	.....	1,532	32,024	4.7
Wisconsin	[27] 1,159	.....	[21] 785	5,070	14,850	75,707	19.6
Wyoming	.....	.....	.....	.....	520	14,797	3.5
Total and average	16,160	75,311	4,490	69,186	287,047	2,455,761	11.6

[1] Also 922 culverts.
[2] Includes 428 miles of grading.
[3] Includes 14 miles of earth roads.
[4] Includes 195 miles of reconstruction.
[5] Includes 25 miles of reconstruction.
[6] 847 linear feet of bridges.
[7] Only engineering and supervision furnished by State. Includes 70 miles of earth roads.
[8] Includes 47 miles of earth roads.
[9] Includes about 6,300 miles of earth roads.
[10] Includes 1,810 miles of earth roads.
[11] Includes 106 miles of earth roads.
[12] Includes 56 miles of earth roads.
[13] Includes 275 miles of reconstruction and 70 miles of earth roads.
[14] Includes 64 miles of earth roads.
[15] Includes 11 miles of earth roads.
[16] Includes 52 miles of reconstruction.
[17] Also 2,330 culverts.
[18] Includes 2,186 miles of earth roads.
[19] No data.
[20] Includes 181 miles of earth roads.
[21] Includes culverts.
[22] All earth roads.
[23] All but 25 miles earth roads.
[24] Includes 224 miles of resurfacing.
[25] Includes 99 miles of earth roads.
[26] Includes 110 miles of earth roads.
[27] Includes 486 miles of grading.

TABLE III. CASH ROAD AND BRIDGE EXPENDITURES FOR THE CALENDAR YEARS 1914 AND 1916

	Year in which First State-Aid Law Passed	State Funds Expended by or Under State Highway Department: 1914	1916	Total Cash Expenditure from All Sources: 1914	1916	Total State Funds Expended for Road Work from Passage of Law to Jan. 1, 1917
Alabama	1911	$170,232	$102,422	$3,949,019	$4,186,384	$688,827
Arizona	1909		441,202	982,721	1,988,221	1,480,590
Arkansas	1913	115,000	55,483	1,522,696	3,443,887	220,483
California	1895		4,285,964	19,171,985	20,392,434	20,857,055
Colorado	1909	301,274	607,628	1,937,546	2,313,208	1,632,379
Connecticut	1895	1,307,381	1,865,948	3,640,963	3,200,948	18,395,527
Delaware	1903	31,000	31,000	511,628	512,000	255,695
Florida	1915	.....	10,484	2,280,255	4,010,484	11,619
Georgia	1908			3,688,172	3,750,000	.....
Idaho	1905	49,812	100,057	1,371,469	1,948,118	672,869
Illinois	1905	387,989	1,119,202	8,734,713	10,356,669	2,805,829
Indiana	1917			14,233,986	13,500,000	.....
Iowa	1904	74,000	90,821	10,187,507	14,427,877	346,756
Kansas	1911	9,080	10,000	5,544,048	5,610,000	40,000
Kentucky	1912	18,000	708,346	2,474,621	4,448,533	1,325,061
Louisiana	1910	161,186	184,533	1,477,572	3,458,643	790,860
Maine	1901	467,149	1,055,250	2,642,007	3,167,215	6,920,459
Maryland	1898	356,845	2,280,000	6,000,652	5,560,000	19,863,142
Massachusetts	1892	242,560	2,701,236	6,091,875	6,499,141	21,701,228
Michigan	1905	657,264	982,939	9,261,998	10,082,939	4,165,640
Minnesota	1905	1,309,956	1,390,525	6,458,940	8,742,278	5,678,699
Mississippi	1915		6,500	3,960,377	3,256,500	6,500
Missouri	1907	277,253	482,860	5,513,049	7,982,860	2,274,032
Montana	1913	13,516	26,150	2,888,400	3,475,569	60,496
Nebraska	1911	.....	110,000	1,796,278	4,500,000	487,850
Nevada	1911			245,014	275,000	20,000
N. Hampshire	1903	491,520	414,669	1,590,464	2,045,410	3,674,458
New Jersey	1891	1,306,596	1,167,843	7,208,287	5,784,354	9,523,419
New Mexico	1909	115,732	385,684	556,399	828,952	1,048,639
New York	1898	8,544,126	9,409,655	23,231,964	19,901,391	106,032,153
N. Carolina	1901	5,000	10,000	5,215,491	5,510,000	48,500
North Dakota	1909			2,402,384	2,711,295	.....
Ohio	1904	1,855,338	2,885,071	14,334,246	12,992,625	14,558,900
Oklahoma	1911		300,000	2,112,681	3,625,000	330,323
Oregon	1913	10,697	165,662	5,310,467	5,955,662	584,637
Pennsylvania	1903	1,976,768	3,663,352	10,424,580	10,985,392	34,464,563
Rhode Island	1902	.....	543,152	446,496	943,152	4,450,936
South Carolina	1917	.....	.....	1,024,480	1,250,000	.....
South Dakota	1911	.....	.....	1,217,809	2,708,000	.....
Tennessee	1915	.....	200,000	2,370,560	4,600,000	203,500
Texas	1917			9,920,079	10,500,000	.....
Utah	1909	157,732	179,400	803,071	1,855,160	989,132
Vermont	1898	458,456	632,800	1,023,941	1,607,800	4,304,364
Virginia	1906	523,578	542,524	3,224,529	3,691,249	3,256,074
Washington	1905	1,343,431	859,672	7,944,717	7,518,343	8,412,461
West Virginia	1909		10,967	2,483,747	5,510,967	[1] 141,945
Wisconsin	1911	1,482,379	950,000	9,880,240	10,570,764	5,169,001
Wyoming	1911	.....	.....	669,661	450,000	43,237
Total		24,220,850	40,969,001	240,263,784	272,634,424	307,937,838

[1] Of this $118,000 was returned to the counties in 1911 by act of legislature.

Military Railway Platforms of Old Ties

Material of all sorts is so scarce now in France that the engineers laying out the various railroads behind the lines experience difficulty in getting material for the platforms on which men and equipment—mainly the latter—are landed. These platforms have to be close to the railroad track and about as high as the distance of the floor of the car from the ground. According to *Le Génie Civil*, a solution of the difficulty has been found in the utilization of old railway ties. Two forms of platforms are in use. One is built between two lines of track, where an earth fill is retained between walls made up of the ties. The other is alongside of one track where the platform fill is retained by a row of ties held back to deadmen. In the double-wall type a trench is excavated and ties set in the hole thus made are held tight by tamping in earth around them. Along the top of the ties then run waling pieces tied across the filled area with iron rods. In the single-row type the ties are likewise set in excavation and sticks driven back of the face form deadmen to which occasional tie-rods from the upper part of the ties are fastened. The fill is then made up to the level of the tops of the ties. It is found easier to excavate holes for the ties and fill in afterward than to attempt to drive them as piles.

Predict Labor Demand Before Job Is Started

New Use of Progress Charts Combined with "Bogey Scores" Makes It Possible To Tell Where and Why Actual Work Varies from Estimate

By Dan Patch
Aberthaw Construction Co., Boston

IN SEEKING a record of a job's actual cost in time and money as compared with the progress schedule made for it in advance, the Aberthaw Construction Co. has modified its methods somewhat, so that it is possible to tell in advance how much weekly payrolls must amount to at each stage of the work; to tell, moreover, not only whether the material progress is up to this schedule on any date, but exactly how far behind or ahead it may be in terms of materials and labor spent; and to tell in addition, whether the work is ahead or behind in cost, and how the work actually done compares, unit for unit, with the estimates. After predicting the weekly labor expenditure, made up of the cost of all schedules to be under way in any week, these methods make it possible to tell definitely in terms of dollars and cents, and without elaborate pencil-sharpening or guesswork, whether the job is gaining or losing and exactly which features of the work are responsible for the variation from the estimate.

The writer will not enter into any discussion as to whether there is any advantage in having a prediction of the size of the weekly roll on construction work in advance of the actual expenditure. But it appears to him to be of importance to those financing the work to know not only how much money is to be spent but when, and of quite as much importance to the contractor to know not only how large gangs he must have but when he will need them.

The construction company for which the writer works has for some time plotted on a progress chart its schedule of dates for the operations to be undertaken on each of its important jobs, as an aid to the logical ordering and delivery of materials to the job and as a scheme for the job superintendent to follow in order to reach the ultimate date of delivery on time. In addition, however, the management desired a method of keeping in the central office a record of the job's effect on the schedule. As a result of this, the new method was devised.

ABERTHAW CONSTRUCTION CO. JOB 1093 FOR SINGER MFG. CO. BRIDGEPORT, CONN.

SUPT. H. V. Sheahan — CHIEF CLERK Harry Mc Donah — COST CLERK R. S. Kellen — ENGINEER J. J. Keane

FOREMAN	ITEM	SYMBOL	QUANTITY	AMOUNT	1st Week Ending 4-11	2nd 4-18	3rd. 4-25	4th. 5-2	5th. 5-9	6th. 5-16
	Clear Site	Das		130	131	151 130	151 130	152 130	152 130	152 130
DEBERS	Dig Footings & Foundations	Dad	768 cy.	577	39 100 45	271 30 130 328	371 449	535 130 488	538 488	538 488
	Sheeting for Footings	Dewp	3000 ♯		88	200 288	200 488	1 488 125	1 150	1 150
	" " Tunnels	Dewp†	570 ♯	71		75	50 125	25 160	31 71	31 71
	Officers & Sheds	Pen		300	64	124 20 140	161 20 40 215	180 16 56 250	180 16 71 250	180 250
	General Plant	P&		150	50 65	59 75 140 75	59 75 215 75	59 35 250 75	59 100	59 100
	Walks, Fences, etc.	Pej		50	50	10 25 75 18	10 25 100 10	10 10 110 10	11 20	11 35
	Unload Lumber	Ful		200		1 1	10 10 10	19 10 20 150	29 10 30 175	30 5 35 185
	" Steel	Ru		215	25	4 50 75 4	97 50 125 116	245 50 175 191	245 25 200 191	278 210
	" Concrete Materials	Mv &	1400	742 258		39 50 20	88 65 115 104	194 50 165 194	194 50 215 194	219 254
	Saw Mill	Pes		100		12 50 12	17 75 125 17	19 85 210 70	19 85 295 70	19 85 380 70
MORAN	Mixer	Pem		300		26 35 20	42 35 70 42	49 70 100	53 120	54 150
	Tower, Hoist, Boom, etc.	Pels		400	8	130 20 85	144 50 70 144	149 50 120 200	152 20 140 260	57 10 150 275
	Forms to Footings		6550 ♯	498	10	14 75 89 12	21 75 160 5	98 100 260 380	105 10 270 440	105 5 275 498
	Steel for Footings & Sundries	R & z	40 T.	320	36	6 184 220 6	43 178 398 52	93 100 498 79	178 96	227 107
	Concrete Footgs & Foundn Walls & T.	Med	517 cy.	646		25 23 20	204 23 26 261	288 23 69 496	405 23 92 568	438 23 115 598
	Forms to Tunnel			132		171	171 342	171 513	41 85 598 114	48 120
	" " Foundation Walls		4688 ♯	363		27	66 41 68 105	127 39 167 106	408 22 129 273	474 3 132 301
	Backfill & Grading	Ded	1123	562		76	36 102 178 86	157 112 290 140	278 11 301 300	365 325
	Dig & Backfill for Plumber	Dedb		25			61 5	122 183 18 20	122 305	20 325

KEY										
Total to Date	Total to D. Chart			32865	316 424	942 1710	1679 3187	2721 4631	3986 5650	5731 7135
" "	"Bogey" " " E.U					942 1020	1679 2150	2678 3695	3620 4792	5731 6431
	Chart P.R				424	1286	1477	1444	1019	1485
	Actual "				316	626	737	1091	1266	1731
								998	1043	1561

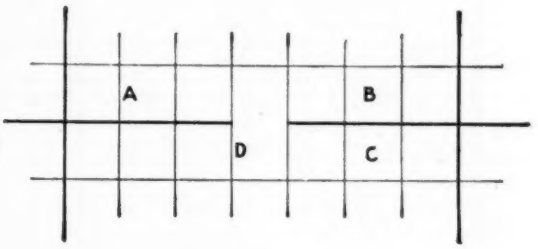
FIGURES COMPARING ACTUAL COST WITH ESTIMATED COST OF ACTUAL WORK DONE AND WITH

The progress chart now has combined with it a "bogey score," or list of items of work with the estimated quantities and amounts of money allotted for their performance. The money allotted for each item is divided up throughout the time scheduled in weekly amounts, which are placed below the schedule line in the middle of the week space. At the right of the week space, below the line, is put the sum to date of these estimated weekly amounts. This, of course, must equal at the end of the line the amount allotted in the "bogey score." When all the money has been thus distributed, each column is added and the total weekly payroll for each determined. These in turn are summed to date, the total equaling the total of the "bogey score."

The prediction of the weekly roll and the total to date are plotted on a progress curve sheet, as shown, in fine lines, the horizontal lines representing the payroll and their connections making the figure resembling the cross-section of a mountain range. The form of this figure will vary according to the type of job and speed of construction. The curve of "total to date" is the typical sinusoid of most construction costs.

With the construction of the chart and curves understood, the methods of following the performance will be grasped readily. The cost of each item is kept by the field timekeepers against the mnemonic symbols set opposite each item in the "bogey score." These costs to date are entered each week in the left-hand side, above the line for each item. But the cost of most items is made up of a quantity of work done at a certain cost. This quantity of work, at the unit cost allowed in the "bogey," is set down in the right side of the week, above the line. The total weekly roll is entered at the foot of the column under the predicted roll, and this roll, less extras, underneath this.

Now, if any one item is considered the rectangle for any week which has passed, it will look as follows:



A—Actual cost of item to date.

B—What cost would be if done at the units allowed in "bogey score."

C—What cost would be if the quantity scheduled had been done at the units allowed in the "bogey score."

D—Predicted weekly expenditure on item.

PROGRESS CHART

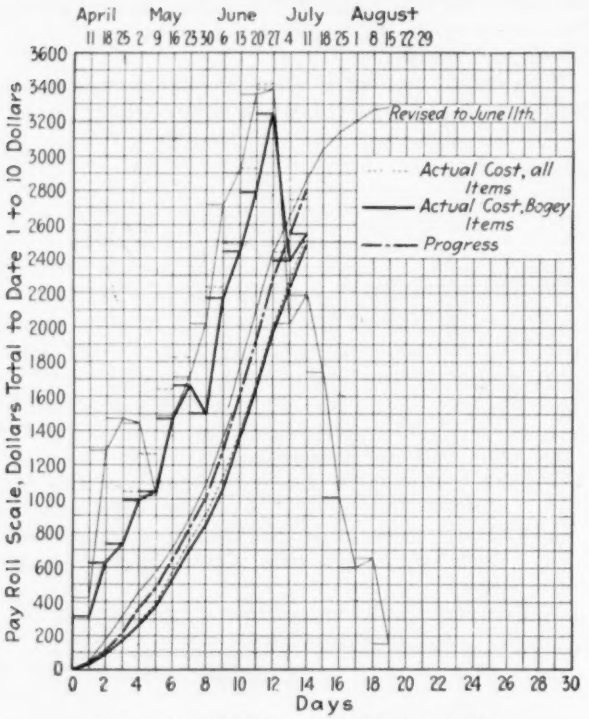
Corrected for Addenda No. 1 & No. 2

7th. 5-23	8th. 5-30	9th. 6-6	10th. 6-13	11th. 6-20	12th. 6-27	13th. 7-4	14th. 7-11	15th. 7-18	16th. 7-25	17th. 8-1
152 130	152 130	152 130	152 130	152 130	152 130	152 130	152 130			
538 488	538 488	539 488	539 577	539 577	539 577	541 577	541 577			
1 150	1 150	1 150	1 –	1 –	1 –	1 –	1 –			
31 71	31 71	31 71	31 71	31 71	31 71	31 71	31 71			
180 250	180 250	187 250	187 250	187 250	187 250	187 250	187 250			
59 100	72 110	86 110	111 110	130 110	142 110	173 110	176 110			
11 35	12 35	12 35	19 35	19 35	29 35	35 35	35 35			
30 185	30 185	30 185	30 200	30 200	47 200	53 200	53 200			
290 215	290 215	290 215	290 215	290 215	290 215	290 215	290 215			
281 291	291 379	522 602	614 743	614 743	631 822	666 868	689 940			
19 85 465 70	19 80 545 70	19 75 620 70	19 75 695 70	19 75 770 70	19 75 845 19	19 45 890 70	19 50 940 70	50 990	Ma½	
55 160	55 170	55 180	55 190	56 200	56 210	65 220	65 220			
163 10 160 280	179 10 170 285	186 10 180 290	200 10 190 295	205 10 200 300	210 10 210 305	213 10 220 310	222 10 230 315	10 240	10 250	25 275
105 5 280 498	105 5 285 498	105 5 290 498	105 5 295 498	105 5 300 498	105 5 305 498	105 5 310 498	105 5 315 498	5 320	5 325	25 350
273 126	313 162	365 161	411 207	478 230	558 253	610 275	638 298			
438 23 138 598	438 23 161 598	438 23 184 598	438 23 207 598	438 23 230 598	438 23 253 508	438 22 275 646	438 23 298 646	22 320		
59 131	61 132	61 132	61 132	61 132	61 132	61 132	61 132			
474 301	474 301	474 301	474 301	474 301	474 301	474 363	474 363			
365 325	374 325	374 325	374 562	374 562	374 562	374 562	374 562			
		9 9	49 25	74 25	96 25	96 25	96 25			

7549 8853	9045 10877	11288 13597	13775 17746	16704 21106	20122 24491	22664 26514	25413 28707	28090 / 24860	3230 = Saving in Cost to Date
6949 8241	8440 10051	10613 12918	13708 16177	16612 19294	19924 22846	22313 25369	24860 28090		
1718	2024	2720	2902	3360	3385	2023	2193	28707 / 28090	
1827	1500	2234	2496	2928	3419	2442	2748		
1664	1495	2173	2440	2903	3313	2389	2547	617 × 6/2193 = 1.7 Days behind Schedule	

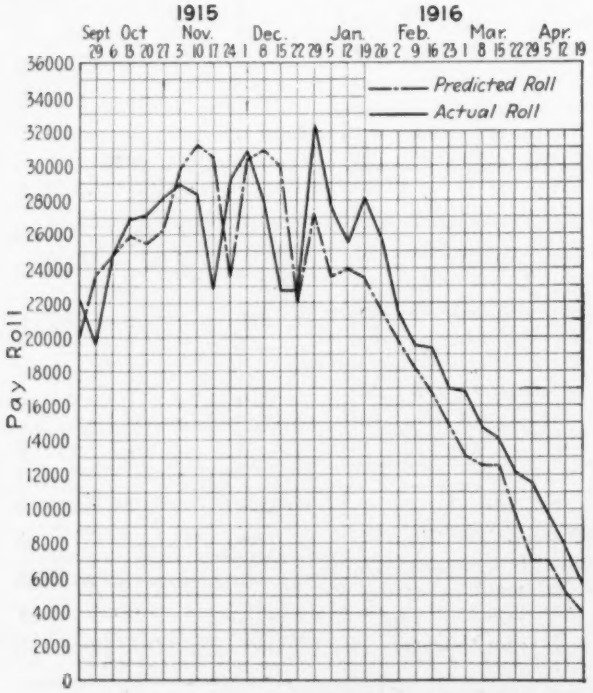
ESTIMATED COST OF WORK SCHEDULED SHOW WHETHER MONEY IS BEING SAVED OR LOST ON EACH ITEM

Then if A is less than B, the job is saving money on the item; if A is greater than B, money is being lost. If B is greater than C, the job is pushing the item ahead of schedule; if B is less than C, the item is behind.


April May June July August
Pay Roll Scale, Dollars Total to Date 1 to 10 Dollars
Days
Revised to June 11th
Actual Cost, all Items
Actual Cost, Bogey Items
Progress

CURVE OF TOTAL PAYROLL TO DATE

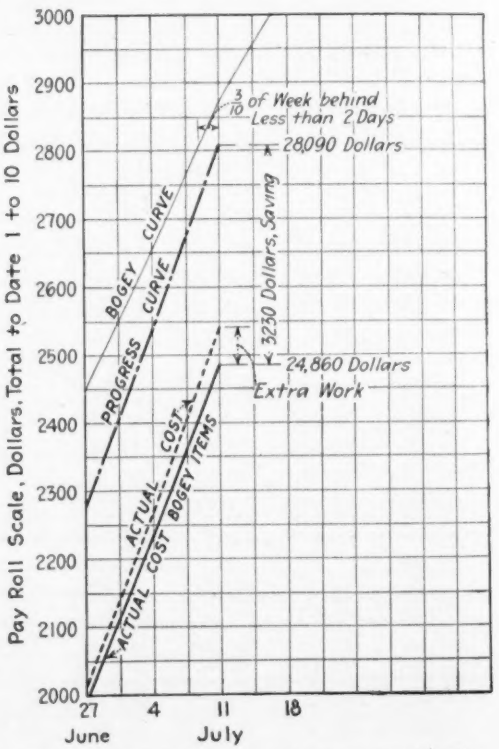
The blueprints which are posted on the central office board are not filled out each week so as to give these detail figures, but a graphic method is used to give the results.



PREDICTED AND ACTUAL WEEKLY PAYROLLS

If any item does not start on the date set, a red line is started above and continued until the item starts or is cancelled. The traveling superintendent is notified of the red line, and he either notifies the office that the item has been found unnecessary, as is sometimes true of sheeting for footings, etc., in which case a white line is drawn underneath, or takes steps to get the item started. When the item starts, a yellow line is placed beneath and drawn up to the point where the money to date, under the line, is equal to the cost to date at "bogey" units; that is, where the value of C equals B. This graphically represents the proportion of the item done, and at the completion of the item, will just reach the end of the item line. As each week is entered, a white vertical difference line is drawn through the date, so that it is more easily seen how the job stands. The bottom of the chart has the standing of the whole job plotted. These results are also plotted for the total job on the progress curves in the heavy black lines.

This description will give the reader an understanding of how the curves to which reference is made are constructed. Now, it is to be noticed how closely the actual results follow the predictions; that is, how similar the heavy is to the light line form. This would indicate that for any given job, a very close approximation to the labor demands and expenditures can be predicted a considerable time ahead. By reference to the chart, the trade of the labor at any particular time during the job can be determined; that is, when masons will be demanded and how many, etc.



GRAPHIC METHOD OF SHOWING PROGRESS

In case of large operations, covering groups of buildings, the superposing of these individual job curves, showing the predicted and actual weekly rolls, of which one of the diagrams for one of the company's large

contracts is an example, will give a resultant curve of the total operations to be financed. Labor is an active liability, and has to be met with cash. Merely dividing the total estimated cost by the length of the job gives no idea of the peak load, which may be of importance. This financial prediction is an interesting, if not a valuable, byproduct of the plans developed for following the progress of the job.

It may be of further interest to note the graphic method of showing the progress on the progress curve sheet. To do this, consider the curves for the job for which the progress chart is shown. Enlarge the section near the terminal of the lines to date of July 11, and the diagram will indicate the conditions of the job. Should the progress line be on the opposite side of the "bogey" curve, then the job would be ahead of schedule; if the curve of the actual cost of "bogey" items should be above the progress curve, there would be indicated an overrun in cost.

High Residual Stresses Exist in Pulp-Mill Digester Shells

HIGH initial stresses in the steel shells of lined sulphite digesters have been discovered as the result of an investigation by A. P. Mills and H. O. Keay, made for the Laurentide Co. and the International Paper Co. Explosions some years ago of these tanks, which in service are filled with hot acid and wood chips, led to the investigation.

On digesters at Ausable Forks, N. Y., and Grand Mere, P. Q., tests were made of the linear expansion of the steel shell before and after lining and under various conditions of service, using a Howard extensometer. The Ausable shells were lined with 1:2 cement mortar, 3 in. thick next to the shell, a 2-in. course of fireclay paving brick, a 1-in. course of cement grout and a 2-in. course of paving brick. The Grand Mere shells had a 2-in. layer of lining cement next to the shell, a 2½-in. course of digester brick, a ½-in. course of cement grout and a facing course of digester brick laid in litharge-glycerine cement. In both cases the lining cement was gaged with a sodium silicate solution.

At the Ausable plant, initial shell stresses up to 5000 lb. per sq.in. were found to have accumulated, and higher stresses than expected were found in each first cook after a cooling-down period. In the Laurentide digesters, the initial stress ran up to 5700 lb. per square inch.

The maximum stresses obtained in service were about double those given by the conventional cylindrical shell formulas. The action is expansion of the cement linings in setting.

Few Meters and High Water Consumption

With only 6.9 of its services and 21% of its consumption metered a per-capita water consumption of 249 gal. a day was indicated at Chicago in 1916, according to the last annual report of John Ericson, city engineer. On a very hot August day the pumpage was 320 gal. per capita, and from 8 to 10 a.m. the rate was 340 gal. per capita. The total pumpage at these two rates was 753,000,000 and 850,000,000 gal. Every available pumping unit was in service.

Government Cost-Plus Contracts for Emergency Building

Percentage Far Preferable to Bidding on Fixed-Fee Basis, a System Discarded Years Ago for Private Contracts

By John M. Goodell
Washington, D. C.

THE MOST conspicuous examples of hurried building operations for the Government are the sixteen national army cantonments, now completed. The essence of those building operations was speed; cost was necessarily a secondary consideration, yet careful attention was paid by the Government officials and the contractors to securing the results desired at the smallest expense. The material market was disorganized, labor conditions were disturbed and transportation was hampered by inadequate car supply and congested terminals and transfer yards. Under the circumstances, it seemed wise to those in charge of the work to offer it to selected contractors of demonstrated experience and resourcefulness on the basis of actual cost plus a percentage fixed by the Government. There was no competitive bidding and the contractor to whom a cantonment was offered merely had the opportunity to accept or decline the proposition.

Although this form of contract worked well, it met with some criticism from persons in high office, unfamiliar with the facts but having the ear of the public. There have been, in consequence, assertions that the contractors made no really earnest endeavor to obtain materials and labor at the lowest possible rates, because by doing so they would cut down their profits under the percentage form of contract. As a result, some of the Government officials are now contemplating asking for bids on the cost-plus-fixed-sum basis, extensively used ten years ago but now rarely adopted, for reasons which it is pertinent to point out at this time.

The great advantage of the cost-plus-percentage contract is that it enables the owner to get what he desires, when he desires it, at a fair cost. If he wishes the work rushed he knows what the unusual speed is likely to cost; if he wishes special care given to troublesome foundations or unusual structural details, he is in touch all the time with what he must pay for this work. If he chooses a responsible and trustworthy contractor, the cost will be as low as practicable. If he is so foolish as to rely on an untrustworthy contractor he is no worse off than he would be under a lump-sum contract, for no form of contract will make an incapable contractor do efficient work.

The Government has on hand an enormous building program in this country and France. Wharves, warehouses and storage depots must be rushed to completion at the earliest possible moment, in order to permit the free flow of supplies to our army and our allies. It is impossible to employ existing facilities beyond a limited extent without causing great hardship to many communities here, for these facilities are needed to meet everyday requirements. It has been a characteristic feature of American development to make little coöperative provision for the future in the matters of storage, warehouse and terminal facilities.

With a pressing need for storage buildings, the primary object of the Government is to obtain them as rapidly as possible. This makes it necessary to construct them under some form of cost-plus contract. Lump-sum contracts would be enormously expensive now. In such an emergency, it is doubtful that the Government should run the risks of taking bids after advertising the work. The Council of National Defense already possesses a remarkable record of virtually all contractors who have carried on construction of different kinds. These records show whether or not the work done was satisfactory to the owners, the financial standing of the companies and similar information indicating their availability for emergency work. The contractors for the national army cantonments and many other extensive emergency building operations were selected from this list, and the results have proved the wisdom of the plan. It saves time, places the work in the hands of experienced men and is not wasteful of public money.

If the cost-plus-fixed-sum contract is selected, instead of the cost-plus-percentage, the Government will find it extremely difficult to settle on a fixed sum. Ordinarily a contractor working under peace conditions estimates what the work will cost, and then adopts a percentage of his estimate as his fixed sum. So far as he is concerned, he does precisely what he would do in preparing a lump-sum bid, except that he does not guarantee to the owner what the finished job will cost, for the owner takes all the financial risk. This form of contract has been unsatisfactory because it was only nominally to the owner's advantage. As soon as the owner called for extra speed or extra work, which would increase the overhead cost of the work to the contractor, the latter hung back just as he would hang back under a lump-sum-bid contract, for his fixed sum was not based on rendering such unforeseen services.

A further great drawback has been found in asking selected contractors to name competitively the fixed prices at which they will do work with all costs paid by the owner. This plan is primarily intended to secure competition where speed is the essential factor in the work and the conditions surrounding the work are so uncertain that the cost cannot be estimated with any approach to certainty. The contractor's overhead expenses, which he must meet out of his percentage or fixed sum, as the case may be, will be about 3½%, as a rule, on large operations. Under the fixed-sum plan he must guess at the maximum cost of the work, in order to ascertain what these charges will be, and then make another guess, usually lower than the first, on which to base his profit. Then he will add the two together and thus obtain his fixed sum. These sums will vary and the owner, knowing how they are obtained, will be in a quandary—whether he should let the contract to the experienced man in that class of work, whose fixed sum is the highest, or to a reputable contractor with experience mainly in other lines, whose fixed sum is lower. He sees that necessarily there has been guessing about several elements of the work, and he wishes he had been sensible enough to escape all these uncertainties by adopting the cost-plus-percentage system.

The case is much simpler with the Government than with a private owner. The Government does not run any risks under the system adopted for the cantonments. It is willing to pay cost, when that cost is the minimum a good contractor can attain, and under the emergency laws it can give the contracts only to parties of demonstrated integrity and ability. It can determine what is a fair profit on the work, making the ratio of profit to cost larger on small work than on big work. There is none of the uncertainty about this which exists in cost-plus-fixed-sum and lump-sum contracts, and it is to be hoped that in these trying times, when the nation is responding freely and gladly to the unparalleled demands for money and services, there will be no experimenting with building contracts which experience has shown are unfitted for emergency construction.

Probable Lives of Water-Works Elements

THE Committee on Depreciation of the American Water-Works Association summarized broadly in its final report the conclusions drawn from data collected by it concerning the life of the elements of a water-works plant. In still more condensed form the figures are:

	Life in Years
Large storage reservoirs, well located	75 to 150
Heavy earth or masonry dams	75 to 150
Large masonry conduits and tunnels	75 to 150
Cast-iron pipe, large	75 to 125
Cast-iron pipe, small	30 to 70*
Wrought-iron or steel pipe, large	30 to 75
Wrought-iron or steel pipe, small	25 to 40
Wood-stave pipe, large	30 to 60
Services, wrought-iron and steel	15 to 30
Services, wrought-iron and lead	40 to 80
Small distribution reservoirs	50 to 75
Standpipes, wrought-iron and steel	30 to 60
Standpipes, reinforced-concrete	50 to 60
Valves	40 to 60
Hydrants	30 to 50
Meters	20 to 30
Pumping machinery, high duty, large units	35 to 60
Pumping machinery, high duty, small units	25 to 50
Pumping machinery, ordinary direct-action	25 to 50
Pumping machinery, centrifugal, not geared	20 to 30
Pumping machinery, centrifugal, geared	15 to 25
Steam engines	20 to 40
Boilers	15 to 30
Electric generators and motors	20 to 30
Filter plants, masonry	30 to 50
Filter plants, wood	15 to 30
Buildings, masonry	30 to 60
Buildings, wood	20 to 40
Stacks, masonry	25 to 50
Stacks, steel	10 to 25

* In slow-growing and small cities, 50 to 90 years.

Explanatory remarks and qualifying conditions are given in the report, which has been printed as a 38-page supplement to the September *Journal* of the American Water-Works Association. Discussion of the entire report on depreciation, for presentation to next year's convention of the American Water-Works Association, is invited by J. M. Diven, secretary, 47 State St., Troy, N. Y.

Shortest Railway in the World

Filing of a court action in Missoula, Mont., disclosed the fact that the Missoula Belt Line Railway is the shortest railway in the world. The attorneys for the company owning the 100-ft. railroad line filed suit in the district court for $8000, said to have been collected by the defendants in their capacity as agents for the railway. The line connects the Northern Pacific and the Chicago, Milwaukee & St. Paul lines in South Missoula, where the tracks of the former pass over the latter. The line has neither equipment nor employees.

Reinforced Concrete in Sea Water Fails from Corroded Steel

Percolation of Salt Water or Salt Air to Reinforcing Steel Causes Rusting with Subsequent Expansion and Failure of Structure—Remedies Are Difficult to Find

By Rudolph J. Wig and Lewis R. Ferguson

Third of Five Articles on the Problem of Sea-Water Concrete Written as a Result of Investigation and Inspection of Practically All the Marine Concrete Structures in the United States.

THE majority of all reinforced-concrete marine structures on the American coasts subjected to sea-water action are now showing evidences of deterioration or failure due to the corrosion of the embedded reinforcement above the water line.

Only after the most careful investigation and with indisputable evidence at hand to substantiate it, do the authors state *that steel embedded in first-class concrete to a depth of one or two inches in accordance with existing theory and practice is not perfectly protected against corrosion by sea-water action.* There is a widespread but erroneous belief among engineers that a comparatively thin coating of concrete will protect embedded reinforcing from corrosion. This view is supported by the leading authorities, and so the average engineer cannot be severely censured for following a practice which has the sanction of those whom he supposes to be well versed in the subject. For instance, the 1917 report of the Joint Committee on Concrete and Reinforced Concrete states, "Tests and experience indicate that steel sufficiently embedded in good concrete is well protected against corrosion no matter whether located above or below water level. It is recommended that such protection be not less than 1 in. in thickness." This also represents the opinion of the authors of all standard works.

Some of the structures examined by the writers are not a year old, and the oldest is but ten. Many of the older structures show signs of advanced deterioration, and some not more than four years old are badly affected, while one reinforced-concrete pleasure pier, opened to the public in July, 1916, was found to be seriously affected by October of the same year. Some of its members are shown in Fig. 1. In that short time the reinforcing had corroded to such an extent that spalling of the concrete had begun.

In many instances where a member has cracked over some of the rods, the cracking has not yet developed over all of them. That is, one corner of a beam or pile may be cracked while the other corners show no signs of fracture. This is due to the fact that some of the rods are embedded a little deeper, the concrete is somewhat denser or the exposure is not so severe.

A number of reinforced-concrete structures were found which were not cracked or deteriorated, but most of these were not over two or three years old. One, however, was ten years old.

Undoubtedly the most important information gained during the recent investigation made by the authors was the true condition of reinforced-concrete structures subjected to the action of sea water, and the cause of the trouble. There have been a number of reports and articles in the technical press describing marine structures of reinforced concrete which have shown signs of deterioration, but as far as is known no one has developed the real conditions.

Some plausible explanation has always been made which has accorded with the existing theory that reinforcing is amply protected against corrosion when embedded to a depth of 1 or 2 in. in concrete of good quality. These articles have described structures in widely separated localities, so it is evident the same forces are at work wherever there is sea water, and the trouble is not confined to any particular part of the country. The effect, however, is much more pronounced in some localities than in others, and certain conditions greatly accelerate the action. The temperature, exposure conditions, quality of concrete and depth of embedded metal all influence the rapidity of deterioration. Some of the reinforced-concrete structures examined by the authors show only slight signs of deterioration after six or seven years of exposure, while others are practically failures within four years of the time they were built.

Usually the corrosion of reinforcing is attributed to the poor quality of the concrete. Porous concrete does of course offer less protection to the embedded metal, and corrosion will be more rapid in such cases. Rein-

FIG. 1. CORROSION OF SLIGHTLY EMBEDDED STEEL HAS CAUSED CRACKING HERE INSIDE OF ONE YEAR

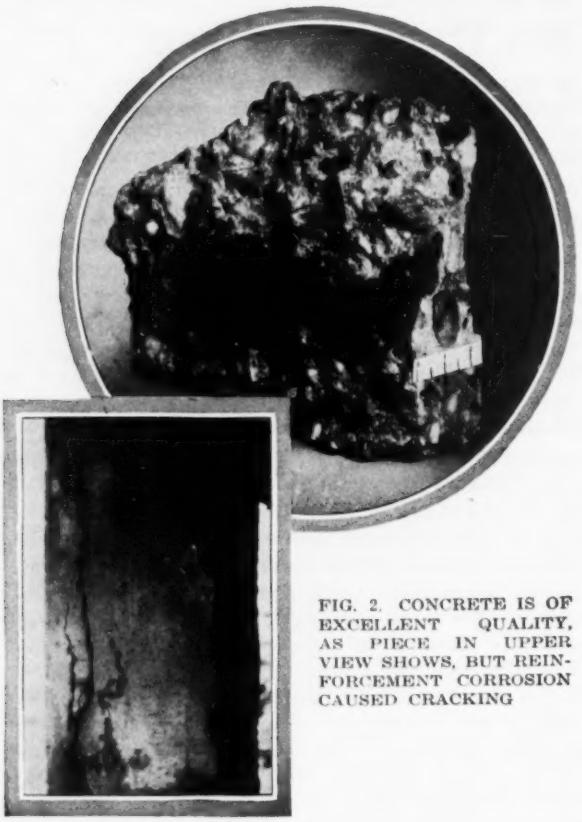


FIG. 2. CONCRETE IS OF EXCELLENT QUALITY, AS PIECE IN UPPER VIEW SHOWS, BUT REINFORCEMENT CORROSION CAUSED CRACKING

forcing will, however, corrode under certain exposure conditions in a few years, even when the concrete is of excellent quality.

There is a reinforced-concrete quay wall or wharf on the south Atlantic coast which was built in 1912 which illustrates this. The design consists of precast reinforced-concrete piles supporting a reinforced-concrete deck. The concrete for the piles was a 1:1½:3 mix, so wet that the rods were thoroughly coated. The ingredients were of excellent quality, and the concrete was mixed and placed as well as if not better than the usual practice. Fig. 2 shows one of the cracked piles and a section of concrete showing its good quality. When this wharf was examined in 1916 it was found that 60% of the piles were cracked at the corners, and in many cases the reinforcing was exposed.

There is another pier along the Atlantic coast built ten years ago which consists of precast concrete piles, but here a wood deck was used. The concrete for the piles was of good quality. In this pier there are about 2500 piles and nearly every one is cracked or spalled. Fig. 3 shows some of the piles.

In the Philippine Islands many of the reinforced structures have cracked to such an extent, due to the corrosion of the metal, that they have caused serious apprehension. The explanation advanced by J. L. Harrison, at one time district engineer at Iloilo, P. I., in an article in *Concrete*, March, 1917, is that the trouble is caused by the use of sea water in mixing the concrete.

Mr. Harrison came to this conclusion largely by analyzing specimens of concrete which had cracked and in these he found an appreciable amount of chlorine. He was on the right track, but the chlorine did not come necessarily from the salt in the water used in mixing the concrete, and, moreover, the conditions he observed would without doubt have occurred had the concrete been gaged with fresh water. He is also in error in assuming "that on the whole the conditions in the Philippine Islands are so different from those which prevail in temperate climates that the results there (in the United States) obtained are not a reasonable criterion of what must be expected here."

Exactly the same phenomena are occurring in America, and in fact everywhere that concrete is exposed to sea water. Under warm humid conditions the action is much more severe and rapid—but more or less rapidly the destructive action is in progress everywhere.

Salt-Water Gaging Not the Cause of Failure

That the gaging of the concrete with sea water, or the use of aggregate impregnated with salt water, is not the primary or underlying cause of the corrosion of the embedded reinforcing is shown by the fact that in many of the structures examined the concrete was mixed with fresh water and the aggregates were free from contact with salt water. This was true of the two piers first referred to where very extensive cracking has occurred. During the investigation made by the authors one of the matters given particular attention was the possible use of salt water in gaging the concrete, and the statement can be made with assurance that the prevailing corrosion of metal embedded in concrete cannot be attributed to the use of sea water in mixing, for with few exceptions American structures have been built with fresh water.

It has been suggested that close proximity of the reinforcing rods to the surface has produced corrosion. In an article in *Engineering Record* of Jan. 25, 1908, p. 105, there is a description of a reinforced-concrete building which was torn down six years after erection. Here it was found that corrosion of the reinforcing had occurred in the columns where the hoops were closer than ¾ in. to the surface, and the necessity of keeping the steel "at least ¾ in. from the surface" is pointed out.

In passing it might be noted that the difference between ¾ in. and 1 in. of covering which the Joint Committee recommends as giving perfect protection against corrosion is a very small margin of safety. As a matter of fact, however, neither ¾ in., 1 in. or, in many cases, even 3 in. of concrete will insure the embedded reinforcing against corrosion in marine structures. In a number of the piles of the pier previously mentioned where the concrete was proportioned 1:1½:3, it was observed that some of the rods which had spalled off the concrete were embedded 2½ in. (see Fig. 2) and were badly corroded, and in many other structures where advanced corrosion of the reinforcing was found the metal was embedded more than 2 in. When the metal is near the surface it will corrode much more rapidly than when embedded to a greater depth, but the thickness of covering must be much more than has been commonly supposed.

Perhaps the most popular theory of the cause of corrosion of metal embedded in concrete is that of electrolysis. A few years ago this was the explanation advanced for practically all the ills of reinforced con-

crete, and in some cases it was made to apply to plain concrete also. Naturally the corrosion of reinforcing in marine structures was attributed to this cause, and a number of cases were diagnosed as electrolysis with little more than a superficial examination. In other cases the examination has been carefully made, but lack of any better explanation than that of electrolysis and the firmly fixed idea that 1 or 2 in. of concrete thoroughly protects the reinforcing from corrosion have led the investigators to adopt this theory.

This seems to have been the case in the second report of the Committee on Reinforced Concrete of the British Institution of Civil Engineers. This report contains descriptions of a number of reinforced-concrete structures subject to sea-water action. Most of these show extensive cracking of the concrete along the lines of the reinforcing rods. The suggestion is made that the trouble arises from several causes—closeness of metal to the surface, improper placing of concrete, causing porous sections, and lack of bond along the plane of reinforcing—but if there is electric current near the structure it is made to take a large part of the responsibility for the failure.

There probably have been some instances where electrolytic action caused the corrosion of reinforcement in marine concrete structures, but such cases are very infrequent, and the effect from this action is different in one very marked particular from that which is occurring in practically all reinforced concrete in sea water which is deteriorating.

The cracking of the concrete in sea water always starts *above the high-water line*, although it may extend a little below this point as corrosion develops. Very seldom is it found to go down as far as the elevation of low water, and then only when the reinforcing is deeply embedded so that the spalling effect extends a considerable distance below where the metal is affected.

This condition was also noted in the report of the British Institution, and it effectually disposes of the electrolytic theory. In all the experiments made to determine the action of electric current on reinforced concrete it has been found that cracking due to the corrosion of the reinforcing starts where the current leaves the rods. Therefore, if electrolysis were the cause the corrosion and cracking must occur below the elevation of high water, where the current leaves the metal. In a reinforced-concrete marine structure in which the corrosion and deterioration do not extend below the water line, electrolysis cannot possibly be the cause. For this reason, also, the corrosion of the reinforcing referred to in the report of the British Institution cannot be caused by electrolysis, for it is stated that the cracking of the concrete occurs above the level of high water.

At Long Beach, Calif., a large number of reinforced-concrete piles were cast in 1911, the intention being to use them in constructing a pier. After the piles were cast the work was stopped. The concrete piles have remained where they were cast, about 50 ft. from the shore, without covering and without any electric current near them. The tide never rises high enough to reach the piles, and so they are constantly dry except from such wetting as they get during the rainy season. Evidently the piles were molded in two operations, one set being of a little better quality—apparently because of the use of a somewhat drier consistency of concrete.

Practically every one of the set made from the very wet concrete has cracked. (Fig. 4.) Cracking has not yet developed in the set made of the drier concrete. Certainly electrolysis cannot possibly be the cause of the corrosion of the reinforcing rods. Fresh water was used in mixing the concrete.

Another very good bit of evidence that corrosion of reinforcing with resultant cracking of the concrete is not due to electrolysis was found in one of the rivers emptying into the Atlantic Ocean. At the mouth of the river there is practically undiluted sea water. About 15 miles from the mouth the water is just perceptibly brackish and 10 miles farther up the river the water is fresh. In this river there are more than 25 beacon lights, and those extend from the mouth to a point beyond where the fresh water is always found. The supports for these lights consist of four precast reinforced-concrete piles supporting a reinforced-concrete slab deck to which is attached the superstructure, consisting of steel members or pipes in the form of a tower.

FIG. 3. THESE PRECAST PILES HAVE ALL CRACKED ABOVE HIGH WATER FROM RUSTED STEEL

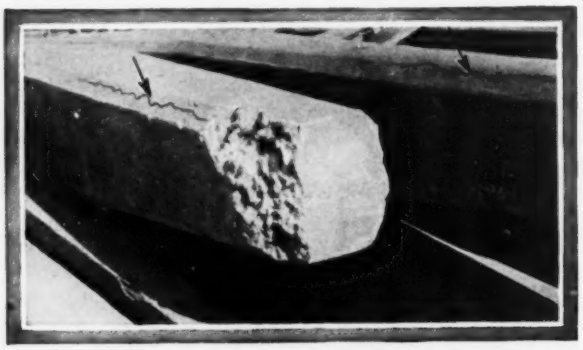


FIG. 4. THIS PILE WAS ON BEACH HIGH ABOVE WATER, BUT NEVERTHELESS CRACKED FROM POROUS PERCOLATION AND SUBSEQUENT CORROSION

This supports the beacon light. All of these lights burn gas or oil, and none of them is operated by electricity; nor is there any electric current near them. In all cases the deck slab is at least 6 ft. above the high-water line, and in a number of the structures it is 10 or 12 ft. above this point. Knee braces were used frequently to stiffen the deck slab.

A very careful examination of these structures showed that not one of those situated in fresh water was cracked or deteriorated. Holes drilled through the concrete into the reinforcement proved that no corrosion whatever had occurred. On the other hand, every structure below the point where brackishness of the water could be detected was cracked from the corrosion of the reinforcing, the action being markedly more severe as the salt content of the water increased. All of these structures were built about the same time, during 1912 and 1913, by the same contractor. The same materials were used for the concrete for all the structures, and it was of excellent quality. It might be mentioned also that fresh water was used in gaging the concrete. All the cracking was above the water line, and in many of the structures the deck slab and knee braces are the most affected.

Undoubtedly the real cause of the trouble is the accumulation of salts in the pores of the concrete above the water line by capillarity and evaporation, and the absorption by the concrete of air carrying very minute particles of sea water. Moisture in this form is transported by the wind a much greater distance than is usually believed. This is shown by the presence of chlorine in the form of sodium chloride. If the moisture from the sea were simply in the form of water vapor from evaporation there would be no salt found in the atmosphere. The studies made on this subject by the United States Geological Survey indicate that finely divided salt spray from the ocean is carried by the air a distance of many miles inland. This probably accounts for the sodium chloride Mr. Harrison found in some of the concrete in the Philippine Islands.

Chlorine and oxygen together form a very active corroding agent. Of course this has long been known, but what we did not before appreciate was that the salt air could penetrate concrete to anything like the depth it really does.

When steel corrodes it occupies about twice its previous volume. The expansive force thus developed by metal embedded in concrete is enormous, and the concrete is soon stressed sufficiently to cause cracking.

The question has been raised as to whether the cracking comes first and the corrosion is a secondary action which in turn further develops the cracking, or whether the primary cause of the trouble is the corrosion of the reinforcing, with cracking as a secondary action. Of course, if structural cracks occur local corrosion of the embedded metal may be accelerated. A number of conditions were observed, however, which seem to furnish conclusive evidence that structural cracking is not the fundamental cause of the trouble, but that the reinforcing corrodes first and this causes the concrete to crack. The cracking is always along the lines of reinforcing, and very frequently no other cracks could be found in the member. It seems probable that if cracking had started first it would be more widely distributed.

Usually when a pile is affected all four corners tend to spall, and if one pile in a structure is cracked many others will be found in a similar condition, and the beams and slabs, if of reinforced concrete, will also be cracked. It is conceivable that in removing the forms from a pile a corner, if the concrete is green, may be slightly cracked; but it is not probable that all four corners would be cracked, and it is still less probable that such careless work should be done throughout the structure. As a matter of fact, most of the structures which were examined and found cracked were built by competent, experienced contractors under rigid inspection. During the construction of one of the piers referred to in the early part of this article, in which cracking has been very extensive, one of the authors had an opportunity personally to observe the work during construction. It was done quite as well as, if not better than, is usually the case; in fact, the firm which had the contract is noted for the excellent quality of its work.

Pile Failures Not Due to Shattering

It has been suggested that the cracks in concrete piles are caused by shattering of the head during driving. This cannot be the case, for most frequently the cracking does not extend to the top of the pile, and many of the piles observed were jetted into place.

There is one pier in the southern Atlantic which is supported on Braxton piles. These piles are made with a heavy cast-iron shoe at the bottom which projects beyond the shaft of the pile. The pile is driven by means of a sleeve which is threaded over the concrete and rests on the shoe, so that the driving is done on the shoe and not on the concrete. A number of piles in this wharf are cracked over the reinforcement.

Of course the cracking of beams and slabs cannot possibly be accounted for in this way. If the cracking is the first action which takes place it is most probable that some indication of this action would have been observed in the beacons in fresh water previously referred to. As was stated before, no evidence of cracks in the concrete could be observed in these. In most cases the cracking stops at the high-water line or a little below it. This is a striking characteristic of the phenomenon. It is inconceivable that if the cracks occurred first they would always be in the same place. The supposition that the corrosion of the metal is originally caused by cracks

in the concrete must be dismissed. The metal first corrodes and then the concrete cracks.

It is very significant that the cracking does not extend below the high-water line. The reason for this is probably because the air does not as readily penetrate the concrete below this point.

Methods of Preventing Deterioration

Just how to overcome the widespread deterioration of reinforced concrete caused by the corrosion of the embedded metal is a difficult problem, and the exact treatment and method to be followed will depend upon the exposure conditions, design and location of the structure. The use of rods of smaller diameter seems to have a beneficial effect. Increasing the distance of the reinforcing from the surface also assists greatly the resistance to corrosion. In precast piles the added weight due to increasing the covering of concrete over the reinforcing must be considered. In many cases the stresses due to bending after the pile is in position are not great above the water line. This condition may be taken advantage of in designing concrete piles for marine structures. For instance, the vertical reinforcing may be bent in toward the center at a point a little below the water line. Usually ample strength in flexure can be provided by care in the design, and the vertical bearing strength of the pile will be but slightly diminished.

In many concrete structures the members are considerably over-reinforced. This is especially true of piles. Every effort should be made to diminish the amount of reinforcing, and if at all possible a design should be adopted which eliminates the metal entirely for the work above water. Perhaps gravity sections and massive work will cost more in the first place, but the additional expenditure will ultimately prove an economy unless special precautions are taken to insure the reinforcing against corrosion. Frequently a combination of reinforced concrete below the water line with plain section above will prove best.

If the reinforcing is made non-corrosive by galvanizing in the vulnerable part of the structure—that is, above water—the destructive action of the moist air will be prevented or greatly lessened, and the life of the structure materially increased. Painting or impregnating of the exposed parts of a concrete structure will be at best only a temporary expedient unless better materials can be found than those now at hand.

Proper Design Difficult to Make

The proper methods to be pursued and the design to be adopted to prevent the deterioration of reinforced concrete subjected to sea-water action depends upon a number of conditions, such as the type of structure, its purpose, the severity of exposure and the climatic conditions. The latter consideration has considerable influence. In warm, humid climates the corrosion of the reinforcing and the consequent cracking of the concrete proceeds much more rapidly than in cool climates where the amount of moisture in the atmosphere is less. It is an interesting fact that reinforced concrete is subject to most rapid attack in localities where plain concrete is but slowly affected by sea-water action, and where the concrete itself is most rapidly disintegrated the corrosion of the reinforcing proceeds more slowly.

Stone-Gravel Road Proves Its Usefulness in Michigan

State Highway Department's Specifications Also Permit Use of Slag for Base and Surfacing

By Donald A. Thomas
Michigan State Highway Department

POSSESSING both strength and supporting power, the gravel-top road with macadam base, evolved by the Michigan State Highway Department, is proving more satisfactory and can be maintained more easily and economically than a wearing course of plain water-bound limestone. The specifications, however, permit a base and top course of slag, instead of gravel. The slag, because of its porous character, is particularly adapted to take and hold a bituminous carpet-coat but only a small mileage has been constructed in this manner. Over 275 miles of the stone-gravel type, known as a class C road, have been built in the state.

For a few years after the creation of the Michigan State Highway Department in 1905 macadam roads constituted as much as 50% of the mileage constructed according to the state's specifications. As the use of the automobile became more widespread, however, the problem of maintenance became a serious one. Some of the roads were rebuilt to a higher type, others were given bituminous treatments, and the construction of macadam roads dropped until now only about 20% of the roads constructed each year are of this type, most of which, after being opened to the traffic until thoroughly "seasoned," are given a bituminous carpet-coat.

Experience with Gravel Roads

Gravel roads, on the other hand, reacted more favorably to the automobile traffic. They did not ravel readily and, when once compacted and maintained in such a manner as to give perfect surface drainage, demonstrated their ability to carry from 200 to 500 vehicles per day, 70 or 80% of which were automobiles, with an annual maintenance charge of from $100 to $300 a mile per year. For this reason and due also to the fact that large deposits of gravel suitable for road metal are well distributed throughout the state, the construction of gravel roads has increased until it approximates 60% of the yearly mileage built.

The success with gravel roads constructed as such led to the resurfacing of a considerable mileage of old macadam roads with a gravel top. The specifications for the class C road recognize the advantages of this combination. Such a road is capable of sustaining heavy loads and at the same time provides a surface that is easy and economical to maintain up to a certain limit. Also, in utilizing local materials for the top course, a cheaper road is provided than any other type of like capacity.

The specifications for the Class C road provide for the construction essentially as follows: Before building any state reward road the plan and profile must be submitted to and approved by the State Highway Commissioner. In the case of trunk line roads the surveys are made and plans prepared by the State Highway De-

partment as required by law. No grades may exceed 6%. The road is graded to conform strictly to the plans and specifications, with due attention given to drainage. Shoulders are formed on either side to retain the metal within the width and depth specified.

Slag Allowed

After the road has been graded and rolled in the manner above described, a layer of crushed stone or slag, not less than 4 in. deep after thorough rolling and compacting, is spread on the prepared bed to such uniform thickness as may be specified by plans or special specifications for the road in question. The material for this course may be an approved grade of crushed limestone, cobbles, trap rock, or slag. When limestone or slag is used for this course it must be that part of the crusher product passing over the 1½-in. section and through the 3½-in. section of a cylindrical screen perforated with round holes. When cobbles or trap rock are used the permissible range is from ¾ in. to 3 in. It is required that the stone or slag be placed upon the road uniformly mixed and, after being spread be rolled with a roller weighing not less than 10 tons, then covered to a uniform depth of from ½ to ¾ in. with stone or slag screenings and rerolled. Water is applied in advance of the roller after the binder is added except on clay subgrades where permission may be obtained to omit the water. The screenings may be that part of the crusher product passing through the ¾ in. screen when crushing the stone or slag for this course.

If it is determined to construct the top course of slag, the same crusher product used in the bottom course is deposited to such a depth as to make the total thickness not less than 7 in. at the edges and 8 in. at the center for roads from 9 to 16 ft. in width, the thickness to be measured after the road is thoroughly compacted. Virtually the same provisions apply to this as to the first course, and, when completed, it should be uniformly smooth and hard and conform to the proposed grade and cross-section.

Gravel Quality

For a gravel top course good, clean bank or screened material is used. For single reward roads this gravel must test 60% by weight—a larger per cent. if possible—pebbles that will be retained on a screen of ¼ in. mesh and will pass through a circular screen with 1½-in. holes. For trunk line reward roads the gravel must test 75% by weight pebbles retained on a ¼-in. screen and passing a 1½-in. screen. If clay gravel is used it should contain only clay enough to coat the pebbles with no free lumps and in no case may the clay exceed 10% of the mass, for clay makes mud and adds no wearing qualities. These requirements are based on the experience of the State Highway Department during the past 12 years which has shown that Michigan gravels are valuable for road purposes as follows:

1. Almost in direct proportion to the percentage of pebbles constituting the mass.

2. In direct proportion to the value as road material of the rock fragments constituting the pebbles.

3. In direct proportion to the value as a cementing material under all conditions of weather, of the finer particles of earth matter constituting the filler or binder.

The gravel is spread on the road to such a uniform thickness as to be not less than 3½ in. deep after compacting, after which it is harrowed, floated, and rolled until thoroughly compacted, and is even and firm and conforms with the grade and cross-section set forth in the plans. Rolling is done only when the gravel has been thoroughly wet by sprinkling or recent rains and at all times begins at the sides, rolling lengthwise of the road, but gradually working toward the center. In the final rolling the whole surface of the roadway, including the shoulders, is rolled from ditch to ditch and the whole road grade left in such perfect condition that water will flow without obstruction to the side ditches.

No matter how painstaking the work of construction may be, however, the final set of the gravel on the ordinary country road will come only under travel, and to insure a good surface the road must be kept smooth during the formative period. For this purpose the most effective tools are the plank and log drags, or some of the various types of steel drags that accomplish the same purpose. These drags should be systematically used after rains, when the gravel is in a packing condition, and in the subsequent maintenance of the road.

Relative to the cost of this type of construction, an aggregate of 26 miles constructed in different sections of the state under representative conditions during 1916 cost on the average $3255 per mile for a 9 ft. width. For a 16-ft. width a total of 17¾ miles averaged $6170 per mile.

Philippine Government Will Analyze All Bad Concrete

THE Bureau of Public Works of the Philippine Islands has started a campaign to determine, if possible, the cause of such failures of concrete and reinforced-concrete work as have developed in the public works on the island. To begin the investigation D. T. Henry, chief constructing engineer, has issued to all the responsible engineers in the department a series of forms for the collecting and listing of data on any structure which does not seem to be up to the required standard. Particularly, reports are expected on structures where failure has started or has been complete. The local engineers are asked to send photographs of the structures, and to make particular notes of a number of items, among which the memorandum notes as most important that samples of sand and water should be sent and that special note should be taken of cases of exposure to salt water, the possible deterioration of cement, porous concrete resulting from too little cement, leaky forms, etc.; weakness of mortar from laitance due to excess water in gaging, corrosion of reinforcement and splitting of concrete. All of these items and many others are recorded on the blanks, which will be kept on file at Manila. When a sufficient number of them has been received, compilations of consequent conclusions will be made.

Author of Ore Dock Article

Through an unfortunate oversight the name of George C. Newton, of Milwaukee, was not given as author of the article on the new ore dock at Duluth, published in *Engineering News-Record*, Aug. 9, p. 257.

Making the Valuation Records Permanent

Forms Used by Chicago, Rock Island & Pacific Railway Keep Information Up to Date Regarding Track, Buildings and Other Structures

By James G. Wishart
Office Engineer, Chicago, Rock Island & Pacific Ry., Chicago

THE FEDERAL valuation now in progress on many of the railroads of the United States bids fair to be the means by which the lines of this country will obtain a complete and up-to-date record of all facilities, including rail and ballast in track, sidetracks, buildings, bridges, fences and other miscellaneous structures owned by them or used under contract or lease. This information is being obtained at a large expense to both the railroads and the Federal Government, and the railroad companies should take advantage of the opportunity and see that the data so obtained are compiled in such shape that they will in the future be authentic, readily accessible to everyone and easily revised and kept up to date.

A system of periodical reports should be required from the operating or maintenance department from which additions, removals or changes can be recorded. Simple forms for reports which can be readily understood by the man on the ground, who will in many instances be a roadmaster or section foreman of limited education, should be adopted. These forms should be printed on letter-size paper, and made in pads. The headings on the blanks should call for all the information desired for incorporation in the records, and a rule should be made and strictly enforced that each report must be completely, accurately and legibly made out before being transmitted to the office of record. The forms should bear complete instructions, on the face where they can be plainly seen, as to the manner in which they are to be filled out and the office to which they are to be sent, care being used in the wording to see that nothing but simple words and plain language is used.

Each report should be carefully checked over in the division office, as this will save subsequent correspondence with the office of record in explanation of discrepancies in the report or indefinitely described items of work with which the recorder in that office is not familiar. It is a good rule to follow in the making up of these reports that the showing of plenty of details will give better satisfaction and more complete records than the showing of only the cardinal features of a piece of work.

After the information from the various reports has been entered in the records the reports should be attached to the copy of the "authority" file covering the work in the chief engineer's office.

Five Most Important Records

The five most important records are those of rail and ballast in main tracks, buildings, sidetracks, bridges (including turntables) and right-of-way fence. These records, as used on the Rock Island, are of letter size, except those for rail and ballast. The originals are made on tracing cloth, thus making it possible to blueprint as many copies as desired and supply each interested officer with a set. These records should be compiled and kept up to date by the engineering department, this department usually being better equipped for this class of work than any of the other departments. Blank forms for the records may be printed on tracing cloth from an electrotype in offices equipped with a printing press, thus saving the draftsman's time and labor of ruling and lettering the headings by hand.

The record and report forms have been used on the Rock Island for several years and have proved satisfactory. They are made out by various officers reporting to the division superintendent. They are checked by the division engineer in the superintendent's office and forwarded to the chief engineer. A report on each form must be made each month whether work is done or not, and where no work has been performed during the month a "blank" report is submitted. These reports are due in the chief engineer's office on or before the fifteenth of the month following that in which the work is completed. The submission of reports for every month is required for the purpose of keeping a check on the making of reports, as the failure to receive any report by the specified date results in the delinquent division being traced for the missing report.

As a further check on the divisions an "Authority for Expenditure" record is maintained by the chief engineer on a form for the purpose. All approved A. F. E.'s pass through the recorder's hands and are entered on this form, and as completion reports are received notation of same is made opposite the A. F. E. entry. A glance over this record enables one to see in a moment A. F. E. work not reported completed which has been shown on the weekly A. F. E. progress report as 100% finished, and the necessary steps can be taken to secure the necessary reports. The weekly A. F. E. progress report is required of each superintendent to show the status of all authorized improvement work on their respective divisions. When all items on a sheet of the A. F. E. record are reported finished, the sheet is destroyed, as this is not a permanent record, being used merely for check purposes.

Sidetracks

The sidetrack-record form is shown in Fig. 1. The headings in this form cover practically every kind of information desired in reference to ownership, cost, date of construction, location and length. In the column headed "Item No." the official track number should be shown. These numbers are assigned by the chief engineer and shown on the station plats, copies of which are sent to the district and division engineers, and are referred to on reports covering changes in existing tracks.

The tracks at several towns may be shown on one page, space being left between towns for the insertion of additional items as changes or additions are reported. The towns may be arranged either alphabetically or in

SIDE TRACK RECORD.

Item No.	Date Laid Removed Etc.	A. F. E. No.	What is Track Used For and Whom Does it Serve	Location From Station No.	Location To Station No.	Length in Trk. Ft From Heads of Sw. Ft Inside Switch Points Limits	Length in Trk. Ft From Heads of Sw. Ft Outside Switch Points Limits	Total Length	Weight of Rail Per Yard Wgt	Weight of Rail Per Yard Track Ft	Kind of Switch Split or Stub	Kind and Number of Frog	C. W. S. or S. of Main Tk.	Kind of Ballast	Cost of Track	No. of Ties Per Mile	No. of Ties Per Rail	No. of Tons of Steel	Remarks State if Owned Wholly or Partially, Give Contract No. Other References, etc.

FIG. 1

ROCK ISLAND LINES

REPORT OF SIDE TRACKS LAID, EXTENDED, TAKEN UP OR LOCATION CHANGED.

LOCATION _____ DIVISION _____ COUNTY _____ STATE _____

ITEM NO.	DATE LAID, REMOVED, ETC.	A.F.E. NO.	WHAT IS TRACK USED FOR AND WHOM DOES IT SERVE	LOCATION FROM STATION NO.	LOCATION TO STATION NO.	LENGTH IN TRACK FEET FROM HEADBLOCKS: NEW TRACK LAID FROM HEADBLOCKS FROM POINT OF SWITCH	NEW TRACK LAID FROM HEADBLOCKS FROM POINTS OF FROG	OLD TRACK EXTENDED FROM HEADBLOCKS FROM POINT OF SWITCH	OLD TRACK EXTENDED FROM HEADBLOCKS FROM POINTS OF FROG	TRACK REMOVED FROM HEADBLOCKS FROM POINT OF SWITCH	TRACK REMOVED FROM HEADBLOCKS FROM POINTS OF FROG	TOTAL LENGTH	WEIGHT OF RAIL PER YARD WEIGHT	WEIGHT OF RAIL PER YARD TRACK FEET
1														
2														
3														
4														
5														

FIG. 2

ITEM NO.	KIND OF SWITCH, SPLIT OR STUB	KIND AND NUMBER OF FROG	KIND OF BALLAST	REMARKS. STATE IF OWNED WHOLLY OR PARTIALLY. IF OWNED PARTIALLY, GIVE NAMES OF JOINT OWNERS AND SAY HOW MUCH EACH COMPANY OWNS.
1				
2				
3				
4				
5				

BUILDING RECORD

Date Built	Description of Building	Foundation	Plan No.	No. of Stories	Dimensions	Material	Kind of Roof	Cost	Present Value	Condition	REMARKS Line References, A. F. E. No. Contractor, etc.

FIG. 3

ROCK ISLAND LINES

DETAILED REPORT OF

Buildings, Coal Chutes, Platforms, Scales, Sidewalks, Stock Yards, Tanks, Turntables, Wells, Suction and Discharge Pipe Lines, Constructed, Renewed, Extended or Removed

_____ DIVISION MONTH OF _____ 191__

STATION OR MILE POST LOCATION	FOR WHAT PURPOSE IS STRUCTURE USED	DIMENSIONS	NO. OF STORIES	KIND OF MATERIAL IN FOUNDATION	KIND OF MATERIAL IN STRUCTURE	KIND OF MATERIAL IN ROOF	COST OF STRUCTURE COMPLETE	DATE COMPLETED	A. F. E. NUMBER	WHAT WAS CHARACTER OF WORK DONE

FIG. 4

ROCK ISLAND LINES BRIDGE AND CULVERT RECORD

Bridge No.	M. P.	Name of Stream and Station	Alignment	Superelevation	Class	Date Built	Name and Length of Spans and Location	Lengths: Timber Trestle	Steel and Masonry Viaduct	Embankment	Total	Height above B.R.	Total Cubic Yards	Timber Structures: Kind and No. Board Feet	Piles: No.	Piles: B.R.	Piles: Butts	A.F.E.	Cost Cubic Yd. Complete	Cost Cubic Yd. B.R.	Cost Cubic Yd. Total

FIG. 5

ROCK ISLAND LINES

DETAILED REPORT OF BRIDGE OR CULVERT CONSTRUCTED RENEWED, EXTENDED OR REMOVED

Division _____ Line. Month of _____ 190__

Bridge No. _____ M. P. _____ over _____ Alignment _____ Superelevation _____ A. F. E. No. _____

Old Structure _____ Length _____ New Structure _____ Length _____

Linear Feet of Old Bridge Filled—East End _____ West End _____ Date Filled _____

Culvert—Kind _____ Size _____ Length _____ Date of Completion _____

Truss or Girder—Kind _____ Length _____ Date of Placing _____

Ties—Kind _____ Size _____ Guard Rail—Kind _____ Size _____

Cost—Superstructure _____ Substructure _____ Culvert _____ Filling _____ Raising Grade _____

Total Cost _____

SUBSTRUCTURE

No. of Pier or Abutment	KIND OF MASONRY Footing	KIND OF MASONRY Walls	PILES No. and Kind	PILES Length	BUILT BY	DATE FINISHED	CHARACTER OF FOUNDATION

FIG. 6

For Timber Trestles, show on the sketch the size and kind of stringers, number per span, and whether single or double length. Show distance center to center of bents, number, kind and length of piles, also spacing of piles under the cap. Show whether framed bents are on piles, masonry or mud sills.

FIGS. 1 TO 6. THESE ARE THE PRINCIPAL RECORD FORMS FOR SIDE TRACKS, BUILDINGS AND BRIDGES

station order, the latter being preferable for many reasons. Nothing but track actually owned should be entered under the headings to the left of the "Remarks" column. Notation of other tracks used but not owned should be made in the "Remarks" column, as should also such notations as contract references, ordinance rights, joint ownership or other pertinent information not included in the other columns.

The monthly report from which this report is kept up to date is shown in Fig. 2. The lower half of this form has space for a descriptive sketch, the same being true of the forms Figs. 4 and 6. This is a printed form which is filled in by the division engineer on the completion of construction, one blank being used for each job. Where necessary to show clearly the location and alignment of a track a blueprint is attached to this report giving all data necessary to enable the recorder to plat the track accurately on the maps.

Buildings and Structures

The form of buildings-and-structures record is shown in Fig. 3. This is also made up on tracing cloth and includes, in addition to all buildings owned or leased, such items as platforms, sidewalks, pipe lines, stockyards and all other miscellaneous structures owned or leased, except those included in the other records. Each structure is numbered and the number shown opposite the entry in the record; and at points where there are a large number of structures it has been found desirable to paint the numbers conspicuously on the structures. These numbers should also be shown on the official station plat and be referred to in the same manner as track numbers.

This record contains, in addition to the column for "Cost," columns for "Present Value" and "Condition," the entries in which are revised annually by the division engineer. Fig. 4 illustrates the monthly report covering the changes, renewals, removals and new buildings erected. This report is handled by the division engineer in the same manner as the sidetrack report. The sketch called for showing location of structure should be in sufficient detail to allow the platting of same accurately on the maps.

Fence records are kept by similar forms, which give a full description as to kind, length, location, age and cost. In this record notation should be made of all instances where the fence is not located on the right-of-way line. This will enable the real-estate department to investigate the reason and where necessary take precautions to protect the company's title to its property not fenced.

Bridge Records

Detailed information required by the bridge engineer's office is kept on form, Fig. 5. On the back of this form, which is printed on heavy or ledger paper, space is provided for a sketch of each structure, and such information as high- and low-water marks, kind of bents, number, kind and length of piles, length of spans, kind of masonry and date built is shown. These sketches are carefully drawn to scale, and an attempt is made to have this record give a complete history of the construction and reconstruction of each bridge from the time of its original installation. Particular stress is laid on the recording of high-water marks at flood periods.

The monthly report by which these bridge records are kept up is shown in Fig. 6. The headings when completely filled in and supplemented by a pencil sketch give a complete record of work done. A separate form is kept for turntables.

Rail and Ballast

One of the most important sets of records is that of the rail and ballast in main tracks. These records are the most elaborate of all, and in complete form consist of five forms of charts and tables maintained by two kinds of reports. The charts and tables serve many purposes and will always be found useful in the engineering department of any large railroad. They give data on the life of rail, disposition of new rail for relaying programs, depth of ballast in track for determining addition-and-betterment charges on reballasting work, and mileage of rail of various weights or of ballast of various kinds in track at any specified date and for reports for the Interstate Commerce Commission or the president's annual report, and for recording the progress of rail relaying or reballasting. These are a few of the many uses to which this set of records is constantly being put.

The five forms of charts and tables are: A chart for recording the monthly reports of completed work; one for permanently recording each year's rail renewals; one for permanently recording each year's ballast renewals; a book record of mileage of various kinds and weights of rail, and a book record of mileage of various kinds of ballast in track.

Monthly Chart of Completed Work

The chart for permanently recording the monthly reports of completed work, of both rail relaying and ballasting, is shown in Fig. 7. This chart is made up on tracing cloth with the lines of two or three divisions, having a total of approximately 800 miles, on a roll. The charts are drawn to a horizontal scale of 5 miles to the inch, and the different lines are arranged in such a way that they can, when blueprinted, be trimmed in sheets and bound in book form, each sheet bearing a complete title, legend and subheadings.

The heavy black line along the top of this chart is for the purpose of bringing out the location of stations. Immediately above this line are shown the station names, 10-mile points and state lines. The 10-mile points are platted with light vertical lines running from top to bottom of the chart. Immediately below the heavy lines are six horizontal spaces extending the entire length of each line or branch. These spaces are for recording the statistics of the rail in track at the end of the previous year as indicated by the headings opposite each space. Two more spaces are provided below these for recording the authorized and completed work. These data are entered on the charts as shown on the diagram. Spaces are also provided as shown for the kind of ballast in track, authorized reballasting completed, kinds of joints in track and those installed during the year.

This chart must be renewed each year, as it is intended primarily as a yearly progress record. To save the time and expense required to retrace these charts

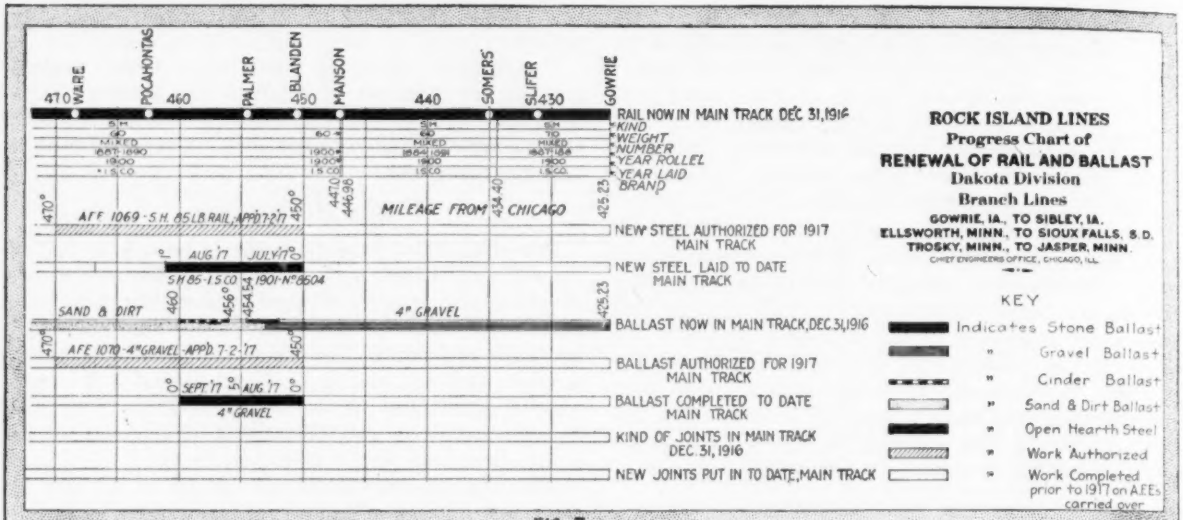


FIG. 7

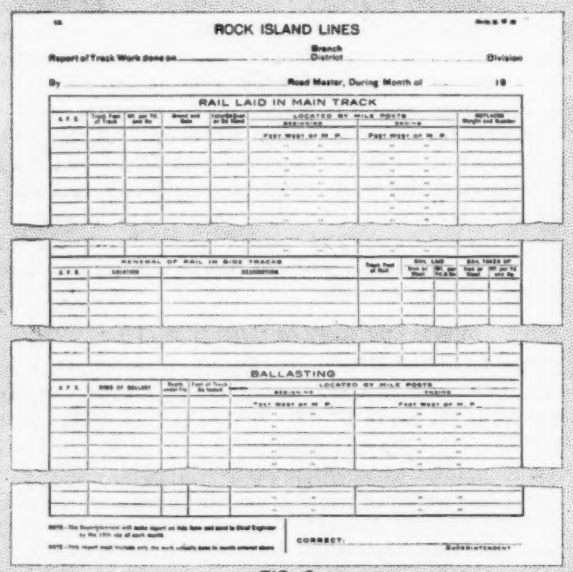

ROCK ISLAND LINES
Report of Track Work done on ____ Branch District ____ Division
By ____ Road Master, During Month of ____ 19__
RAIL LAID IN MAIN TRACK
RENEWAL OF RAIL IN SIDE TRACKS
BALLASTING
CORRECT:

FIG. 8

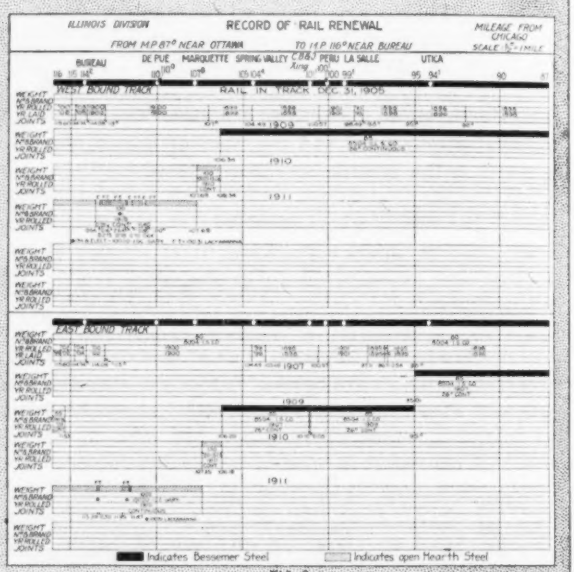


FIG. 9

PROGRESS RECORD OF RAIL RENEWAL - 1915
IOWA DIVISION

FIRST DISTRICT — MAIN LINE

STATIONS FROM	STATIONS TO	STATE	RAIL WEIGHT	RAIL SEC. No.	RAIL BRAND	YEAR ROLLED	YEAR LAID	MILES INTR'K. 12-31-'14	JAN TO MAR MILES LAID	JAN TO MAR MILES REM.	JAN TO MAR MILES INTR'K	APR. TO JUNE MILES LAID	APR. TO JUNE MILES REM.	APR. TO JUNE MILES INTR'K	JULY. TO SEPT. MILES LAID	JULY. TO SEPT. MILES REM.	JULY. TO SEPT. MILES INTR'K	OCT TO DEC. MILES LAID	OCT TO DEC. MILES REM.	OCT TO DEC. MILES INTR'K
E. DES MOINES																				
N.W. WYE TO	SHORT LINE	IOWA	85	8504	I.S.CO	1912	1912	0.02												
S.W. "	"	"	"	"	"	"	"	0.02												

FIG. 10

FIGS. 7 TO 10. THESE FORMS, WITH TWO SIMILAR ONES FOR BALLAST, COVER RAIL AND BALLAST FULLY

where the mileage of the road is large, vandyke prints on thin cloth are made at the close of the year's work and filed for record, the tracings being then revised to show conditions at the beginning of the following year. In this way the tracings can be used for many years before wearing out, and can finally be filed as the record for the last year in which they are used.

The report form by which these records are kept up to date is shown in Fig. 8. This is a monthly report made up and handled in the same manner as the previous reports described. On divisions where a large amount of rail-laying or ballasting is in progress a weekly report has also been required, on a form for the purpose. However, unless close tab is to be kept on the

progress of work, this report is unnecessary. The monthly report is taken as final; where the weekly report is used it serves as a check on the accuracy of the other.

The chart for permanently recording each year's rail renewals is shown in Fig. 9, and a similar one records ballast renewals. These records show in condensed form the work done from year to year and the improvements made in rail and ballast conditions. The total depth of ballast at any point can be readily determined from the ballast record, this being necessary information required in making up estimates for this class of work in order to determine A. & B. charges.

Fig. 10 shows the form of book record in which are recorded the miles of different weights and kinds of rail, and a similar one shows the mileage of different kinds of ballast in track. These mileages are revised at the end of each quarter-year, and a summary is compiled by divisions separating main and branch lines.

The records described, as previously stated, are all blueprinted and bound in book form by divisions, and every officer interested in any way is furnished with a complete set of the records covering his district or division. The division engineer is instructed to keep a copy corrected up to date, so that it will at all times reflect the true situation on his division. At the close of the calendar year, which is now the close of the fiscal year also, the division engineer is required to send his corrected copy to the chief engineer. The chief engineer's office also keeps a copy corrected monthly from the reports as they are received. At the close of the year the tracings are revised to agree with the corrected copies and monthly reports received from the division engineer, and new sets of blueprints issued to all concerned.

Run-Off Equaled Rainfall

A RAINFALL of almost 0.20 in. an hour for eight hours, under conditions that probably caused a run-off of the same rate, occurred at Chicago on Jan. 20 and 21, 1917. Many of the sewers tributary to the 39th St. sewage-pumping station of the Sanitary District of Chicago, designed for a run-off only a third of the rate stated, were overcharged. This resulted in flooding the basement of the 68th St. water-works pumping station, the pollution of the suction wells and a subsequent outbreak of typhoid fever. Months afterward a joint investigating committee representing the Health Committee of the City Council and the Engineering Committee of the Sanitary District of Chicago was appointed. From the report of the committee, submitted during the present year, the following notes on the heavy rainfall and run-off, the heavy loss of capacity in some centrifugal sewage pumps, running in one case to 55%, and the water-supply pollution and typhoid outbreak have been taken. Langdon Pearse and Isham Randolph were engineering members of the investigating committee.

The rainfall under consideration began about 8 p.m., Jan. 20. It was preceded on that day by warm weather which thawed snow on the ground, but for seven days prior to Jan. 19, the maximum temperature was below freezing and on four of the seven days the minimum was below zero, "so the ground was frozen and impervious at the time of the rainstorm."

From about 8 p.m. to 11 p.m., Jan. 20, the rainfall was 0.24, the next hour it was 0.18, and from 12 to 7 a.m. it averaged 0.20 in. per hour. In the next hour only 0.05 fell. Between 11 and 11.35 a.m. 0.04 in. came. Then the storm was over, with a total of 1.91 in. These figures were recorded at the Federal Building, which is the only one of the five stations which shows the rate per hour. At four other stations the rainfall was 1.97, 2.04, 2.29 and 2.54 in., the latter station being in the center of the sewerage district. The 1.91 in. recorded at the Federal Building exceeds all January records at Chicago for 45 years. There have been heavier rainfalls at Chicago in other months, but "very few that have caused a run-off from the territory under consideration that has exceeded the run-off from this storm."

Tests of four centrifugal pumps of the 39th St. sewage-pumping station showed loss of capacity, compared with official contract tests, of 6.2% to 55%. The figures are as follows:

Pump No.	Head or Lift, Ft.	Rated Capacity, Sec.-Ft.	Loss of Capacity, Official Test, Per Cent.
1	24	75	55.0
2	24	75	36.0
3	7	250	19.4
4	7	250	6.2

The heavy loss of capacity, especially in pumps Nos. 1 and 2, is attributed to the condition of the impellers. The report states that "the impeller clearances have never been taken up nor have the pumps been examined internally since installation." In addition to the impeller defects, the main shafts of Nos. 1 and 2 "revolve with an eccentricity of approximately $\frac{3}{8}$ in.," due to wear in the main bearings and displacement of the crank disks.

Flooding the basement of the 68th St. water-works pumping station with sewage at the time of the storm was followed by 223 cases of typhoid fever in the water-supply district, of which cases 105 had nothing in common except the water-supply. The cases continued to be reported, notwithstanding the prompt disinfection of the suction wells. Tests made at the time indicated that one of the suction wells was infected by polluted groundwater that entered through old brickwork.

More Water Meters Would Pay

With 90% of its 10,871 services metered, Duluth, Minn., had a daily water consumption of 82 gal. per inhabitant and 91 gal. per consumer in 1916. The metered consumption was 55% of the total. Allowing 20% for leakage, the 10% of flat-rate consumers used about 25% of all the water supplied, or 2½ times as much as the average for all customers. This is all the more notable when it is considered that only small consumers were on the flat rate. If the 10% of flat-rate consumers who are using 25% of the water pumped should have their consumption reduced to the same average rate as 90% who are using 55% of the water, says D. A. Reed, manager of the Duluth Water-Works, in his 1916 report, the saving would be 25% — 6% = 19%, or 555,250,000 gal. a year. The cost of power alone thus saved would be $3500 a year, which in four years would be sufficient to finish metering the whole city.

Resurface Old Macadam Roads with Rock Asphalt

Method Employed in Kentucky Costs from $6000 to $7000 Per Mile for a Roadbed 14-Feet Wide

ROCK ASPHALT for resurfacing worn-out macadam roads is used largely in Kentucky in those counties which have not money enough for more expensive types of construction. In fact, so little work has been done on some of the routes that large portions of county bond issues, ranging from $100,000 to $1,000,000, are being spent for grading, particularly in the mountainous sections.

To save the old waterbound roads has been one of the chief tasks of Rodman Wiley, state road commissioner. He has met with such success in the use of rock asphalt surfacing that he is of the opinion that this material offers an almost ideal solution to the problem in Kentucky. The rock asphalt is mined in the southern part of the state near Bowling Green, and can be purchased on cars at Bowling Green for $4 a ton. It is easily handled, does not harden unless compressed, and requires none of the equipment necessary to build bituminous pavements of other types. In fact, the only machine used is a pulverizer in the form of two spiked rolls driven by a small gasoline engine, which is used to break up lumps and cakes after the material has been unloaded on the road. In appearance the rock asphalt looks like a very lean sheet-asphalt mixture, but it is not sufficiently sticky to leave marks on the hand when grasped. It contains from 8 to 12% bitumen.

CENTURY-OLD TELFORD FOUNDATION ON DIXIE HIGHWAY ROUTE

ONLY EQUIPMENT REQUIRED IS PULVERIZER

LIMESTONE MACADAM SURFACED WITH ROCK ASPHALT

An old macadam road to be repaired is first scarified, new material is added and thoroughly rolled. The process is exactly the same as for the construction of a waterbound road, except that the screenings and binder are not added, the surface being left rough and coarse. On the surface thus prepared is spread about 3 in. of the rock asphalt exactly as it is received. This layer is thoroughly rolled; in fact, it requires more rolling, if anything, than sheet asphalt paving. A 3-in. layer of loose material compresses to about 2 in. The best results are obtained on the hottest summer days.

The road is ready for traffic almost immediately after the rolling is completed. The surface resembles sheet asphalt and, according to the Kentucky road officials, shows excellent wearing qualities. In the vicinity of Lexington some rock asphalt has been down for nearly two years and has required little or no maintenance. When repairs are required, however, the process is as simple as the original construction, for it is only necessary to square up the edges of the hole and tamp in the necessary amount of bituminous material, which, apparently, will keep "green" an indefinite time when not compressed.

Compared with mixed asphaltic concrete surfacing, the rock asphalt surfacing costs about half. It can be laid by a county gang of ten or a dozen men at a cost of from $6000 to $7000 a mile for a 14-ft. road, including the cost of reshaping and preparing the macadam.

Storage Closets Under Stairs Dangerous

Renewed warning against the practice of building storage closets under stairs or near fire-escape exits is voiced in a bulletin just issued by the Pennsylvania Department of Labor and Industry. The warning is directed chiefly to the case of school and factory buildings of non-fireproof construction. Brooms, papers and rubbish are likely to be stored in such closets, and in the location described the resulting fire danger is a serious menace to the occupants. Experience of the department in examining plans for buildings shows the renewed warning to be needed.

Professional Questions

Engineers are urged to send to the Editor comment on cases presented in this section or statements of their own experiences in matters of professional ethics.

Communications must be signed, but names will be withheld from publication, if the writer so desires.

One Method of Securing Tentative Bids for Estimates

IN PREPARING designs and estimates for submission of a bid for engineering services, in which the advance estimate was to be included, a firm sent notice to contractors calling for bids in such form that the contractors would be inclined to think that the firm had already been retained as engineers for the work. Claim has been made that this is misleading and amounts to sharp practice or possibly unprofessional practice. No specific showing is made that anyone has been damaged other than with respect to publicity value.

Should Advertising by Engineers Be Controlled?

WHILE the old standards of proper professional practice were opposed to advertising by engineers, such advertising is done nowadays to a considerable extent. Well-known consulting firms follow the practice. The old rule seems to be obsolete. Some advertising of "engineers" has recently been brought to the attention of *Engineering News-Record* of which the following is a sample, taken from a daily newspaper in a small city:

> A——B——, Consulting Engineer
>
> Expert advice given on machinery repairs and new work, foundations, buildings and machinery of all kinds. Will superintend any work at a moderate price. All kinds of trouble corrected. Address

The advertisement will not mislead an engineer, but it can mislead many laymen. The result of employing the advertiser is likely to hurt the reputation of the profession. However, there is no agency by which such advertising is restricted. Do conditions through the country indicate a need for such control?

Does Engineering Etiquette Restrict Advice?

A QUESTION involving professional courtesy or etiquette recently arose between two Eastern engineers. One of them is regularly employed by a large corporation owning several important structures. Foundation extension seemed to be required for a structure among them, and the corporation instructed its engineer to prepare plans for the work. Subsequently the president of the corporation desired to have an outside opinion on these plans, and he took the matter to a consulting engineer. The latter's associate, it happened, was a personal friend of the corporation's engineer, and because of this circumstance no question was raised by the consulting engineer.

The subject was studied and a report rendered, condemning the plans first prepared and suggesting a conference with the corporation's engineer for determination of best procedure. Soon after this report was sent to the corporation, the latter's engineer wrote a strong protest to the consulting engineer. He claimed that the report condemning the first plans was rendered in violation of professional etiquette, as the agreement of the original engineer to the second investigation had not been asked. On this ground he requested that the consulting engineer withdraw his report.

The propriety of this protest was conceded by the consulting engineer and the report was withdrawn. The corporation is left with the first set of plans, subject to its own engineer's revising his original views.

Public Officials Ask Engineers To Guarantee Cost

MODERN methods of carrying on engineering business brought about a singular complication in the case of a large highway bridge about to be built in one of the central states. Sharply divergent views concerning the proper attitude of an engineer in such a complication have been expressed. The case therefore, is sure to repay study. The propriety of an engineer's guaranteeing the cost of a structure which he designs, or rather making his fee depend on getting bids within the guaranteed cost, is involved as the main issue.

This particular case is complicated by numerous difficulties which have nothing to do with the contingent-fee question. The following abstract is limited to those elements that bear on this question.

County officials found that a bridge was required at a new location. Before going before the people for a bond-issue note they employed an engineering firm to make preliminary studies as a basis for fixing the bond-issue amount.

Thereafter the amount of the issue was fixed (about $1,000,000), and when put to vote of the people the bond-issue was approved. It was now necessary to secure an engineer to design the bridge and supervise its construction.

The data collected in the preliminary study were placed at the disposal of half a dozen engineers prepared to undertake the work. In asking for their proposals, the county commissioners called attention to the necessity of constructing the bridge within the bond issue. The engineers submitted their propositions, and two of them accompanied it with an estimate of cost; of these, one offered to guarantee his cost figures by forfeiting his fee if the bids proved to be too high. The other engineers were then requested to make similar guarantee, but several of them declined to do this.

The county commissioners first dropped from consideration all but the two engineers who had presented estimates of cost, and then decided in favor of the engineer who was willing to guarantee the estimate

The contract made with this engineer provides for paying him a percentage fee if the lowest acceptable bid plus the fee does not exceed a specified amount (which is well below the bond issue), and absolves the county from any obligation toward him if the bids fail to come within this limit. If on the first call for bids no bids within the limit are received, a second call for bids may be issued; the time of issuing the calls for bids is not restricted.

The case has many interesting sides. Questions that arise at once are: Is this a contingent-fee case? Is it good practice for consulting engineers to design work under guarantee of cost, it being assumed that the extent of the work is so fixed that topping off a part to reduce cost is not practicable? Are objections to such practice merely traditional or is the practice such as to threaten unsound results? Do the exigencies of public bond-issue affect the case? Is such design comparable with architectural design in respect to consideration of sound professional practice?

Architects commonly oppose conditional contracts as unprofessional, though it is said that this rule as well as the rule governing fee percentages is frequently broken. Lawyers recognize contingent-fee contracts as permissible. The engineering profession appears to have no rule on the subject.

Tolls for Road Maintenance Collected in Virginia

(Editorial Correspondence)

JUDGING from a motor trip across the State of Virginia practically all the improved roads are toll roads, but with some few exceptions these roads are owned by the public and toll is collected for maintenance and not for profit. A good example of this Virginia practice is in Augusta County, of which Staunton is the county seat. This county owns and operates a 125-mile system of toll roads, nearly all of it improved with some form of bituminous macadam. The monthly income from tolls amounts to $3500 and all but the 15% required for collection goes back into the roads. The law requires that it must be used for maintenance. Not over $200 of it can be expended for equipment. The attempt has been made, as far as possible with available data, to adjust the amount of toll to the damage done the road surface by various kinds of traffic.

The following toll schedule is of interest as showing the sources from which the maintenance fund is derived and in what proportion: For 20 hogs or sheep, the rate of toll per mile is 1c.; 20 cattle, 2c.; a horse, mule, mare or gelding, ½c.; 1-horse vehicle, ½c.; 2- or 3-horse vehicle, 1c.; and 5-horse vehicle, 1½c.; 6-horse vehicle, 2c.; ponies and cart and ponies horseback, ½c.; 2-passenger automobile, 1½c.; 4- and 5-passenger automobile, 2c.; 7-passenger automobile, 2½c.; traction engine, water tank attached, 6c.; each machine or wagon attached to engine, 2c.; motorcycle, 1c.; trucks of capacity up to 1000 lb., 3c.; trucks of capacity from 1000 lb. to 2 tons, 4c.; trucks exceeding 2 tons capacity, 5c.

For the collection of tolls gate-houses are provided about every 5 miles. The gate-tenders are given free house rent and fuel, and are paid $15 to $25 per month. As the housewife or older children can take in the tolls, the head of the family pieces out his income in any available manner.

Of course it is practically impossible to keep any close check on the cash taken in by the gate tenders, so that both for convenience of the traveling public and to insure the money reaching the county treasury mileage books have been devised. These are similar to railway mileage books, each coupon representing one cent. Books of 500 coupons are sold at a 30% discount. Where the distance traveled does not amount to a one-cent toll, one cent is charged except that in the case of vehicles taking children to school the gatekeeper may keep an account of the actual mileage and the patron may settle each week.

Rules and regulations are provided governing the use of the road, and farmers living along the line are appointed special policemen to see that these rules and regulations are enforced. Any violation of the rules is deemed a misdemeanor and is punishable by a fine of not less than $5 nor more than $100.

In most instances the roads are originally improved under road-district bond issues, and the people of the county are not free from road taxes because of the toll system. The interest on these bonds must be paid by taxation and there is a general tax for the maintenance of earth roads not in the toll system. But the burden of upkeep on the most traveled roads is put squarely on the users of the roads. Obviously, however, there would be difficulties in collecting toll on roads carrying congested traffic, as some of those leading out of large cities.

The Virginia toll roads are not unpopular with the farmers who live along the way, but they are very unpopular with the city motor-vehicle owners and with tourists.

Concrete Base Is Laid on Old Paving

Laying concrete base of new pavement on top of old asphalt pavement is a peculiar construction followed in some cases in Chicago where settlement has occurred due to deep foundations for buildings. On Jackson Boulevard west of Wabash Ave. there has been settlement recently resulting from the construction of the new Kimball Building and Lyon & Healy Building. Where the settlement has been enough to permit construction of a new concrete base, at least 4 in. thick, the old asphalt paving is not removed. Wherever the settlement is not enough to permit this, the old asphalt is cut out and the required grade obtained with either concrete or binder, according to the thickness required. In some places the settlement has been found to be as much as 12 inches.

In many cases where buildings of this character, with concrete pier foundations and deep basements, are constructed, a settlement of the adjoining street surfaces results. The worst case was that of the Karpen Building on Michigan Ave., where the settlement extended clear across Michigan Ave., a distance of over 80 ft. This repaving work is under the direction of the South Park Commission, of which Linn White is chief engineer.

Motor Trucks Haul Heavy, Bulky Loads Up Mountainside

Steel Support and Million-Dollar Mirror for Great Mt. Wilson Telescope Safely Delivered in Nine Trips

By Frank Reed
Los Angeles, California

SAFE delivery by motor truck of the great mirror for the telescope of the Carnegie Solar Observatory at the summit of Mt. Wilson, near Pasadena, Calif. (described in *Engineering Record*, June 17, 1916, p. 802), terminated a series of nine notable motor truck haulage trips. The last trip was noteworthy for the extreme value of the load rather than any difficulty in transporting it. Nominally valued at $1,000,000, the mirror is at present considered to be an almost priceless piece of property. The safe delivery by motor truck justified the confidence of the observatory officials in this method of transportation up the difficult mountain road from Pasadena to the summit, which had been successfully employed in hauling the huge structural steel units of the telescope and its support.

The mirror for the telescope is 100 in. in diameter, 13 in. thick and weighs 4½ tons. To facilitate haulage, provision was made for a mounting which would accomplish two essential objects: First, reduce risk to the mirror by providing a type of attachment which would make truck body and load practically a rigid unit; second, cushion the mirror against road shocks. This result was accomplished by supporting the mirror in a heavy timber cradle from which it was separated by coil springs and rubber bumpers. The mirror was transported to the summit upon a 5½-ton Mack bulldog type truck driven by J. A. Stoner, western manager of the International Motor Co. and Los Angeles distributor of Mack and Saurer trucks. This trip, necessitating an ascent to 6000 ft. altitude in 9 miles, was made in only 5 hours, 10 min.

THE 3½-TON TRUCK SAFELY DELIVERED THE 10-TON TELESCOPE BASE—AT PLACES LIKE THIS MULE TEAMS WOULD HAVE BEEN USELESS, OWING TO FREQUENT BENDS IN ROUTE

MOTOR TRUCK WITH COSTLY TELESCOPE MIRROR NEGOTIATING HAIRPIN TURNS ON STEEP GRADES

The complete series of trips made in delivering the telescope material constitutes a noteworthy record of successful reliance on high factors of safety provided in the motor trucks used. Eight trips prior to the delivery of the mirror were made with loads of structural steel units for the telescope and base. Two of these were made with Mack trucks and seven with Saurer trucks. The largest single loads delivered were two 13-ton steel girders taken up with a 6½-ton Saurer truck, and the worst load from the standpoint of difficulties encountered and overcome was the huge 10-ton base carried up on a 3½-ton Mack truck. The latter piece was so wide and so high that it scraped down chunks of rock from the inner side of the mountain roadway, forcing the wheels of the truck to slide laterally toward the chasm at the outer edge of the road. In fact, at one point near the upper end of its journey the wheels were so close to the edge that the crushing strain caved the road and the outer rear wheel went down until the axle touched the ground. For two hours the truck was in a highly distorted position while supports were being placed and the rear axle was jacked up to a level position again. Then the engine was started and the truck went forward under its own power as if no accident had occurred.

Without motor trucks the delivery of the materials to the observatory would have been an engineering problem of extreme difficulty. The steepness of the grade, combined with sharpness of the turns, made it impossible to use mules, as a sufficient number of mules to move the load would have wound themselves up on the turns. The only alternative, apparently would have been to build runways and use the laborious process

of winching, which would have required blocking the trail to all other traffic and months of time and extraordinary cost for moving up each piece.

Delivery of materials by motor truck was started with an irregular shaped structural steel unit of 22,235 lb. Other loads, varying in size from 8 to 13 tons followed, the mirror taken up on the ninth trip being the only load which did not constitute an overload for the rated capacity of the trucks.

Pennsylvania Will Build Only Heavy Traffic Highways

State Highway Department Will Concentrate Efforts on 3300 Miles of Intercounty Routes with City Pavement Surfacing

CHIEF ENGINEER W. D. Uhler, of the Pennsylvania State Highway Department, has a $6,000,000 construction fund to spend between June 1, 1917, and June 1, 1919. As practically all the state highway work is done on an equal payment basis with the local authorities, the actual money available for new construction will amount to $12,000,000 or more.

With the creation of a state highway system in 1912 and by subsequent acts of the legislature, the burden of building and maintaining 10,000 miles of road was shifted from the local authorities to the State Highway Department. The attempt to pass a bond issue for the improvement of this system of roads was defeated by popular vote. Whatever pavements have been constructed have been paid for either out of the motor-vehicle license fund, or the state aid construction fund.

The utter impossibility of paving 10,000 miles of road under one bond issue or according to any one program has always been recognized by the engineers of the Highway Department, and under Mr. Uhler's administration every effort has been made to concentrate immediate attention on really important routes. To this end a 3300-mile system of intercounty roads has been recommended, the construction of which Mr. Uhler considers absolutely essential before any state money is expended for permanent pavements on other roads.

Only Heavy-Traffic Pavements To Be Built

According to the policy adopted by Mr. Uhler only those types of pavement capable of carrying heavy traffic will be built on these 3300 miles of road. As a general proposition no pavement will be built into the construction of which cement concrete does not enter either as a base or wearing surface.

This decision has not been reached without due consideration. The maintenance division of the Highway Department has struggled for five years with the upkeep of various forms of macadam construction under constantly increasing traffic. Under present conditions and with the prospect of greatly increased use of the roads by motor trucks, Mr. Uhler has decided he "must build for the future." That means a city type of pavement.

The concrete foundation for pavements is to be 5 in. thick unless otherwise provided for. The mixture is to be 1:9, and the mixing must be continued for a period of 1½ min. in a batch mixer making not less than 14 nor more than 20 revolutions per minute. A mixture must be produced "which will flatten out and quake when deposited in place, but not be wet enough to flow or for the mortar and coarse aggregate to settle; the quantity of water is determined by the engineer and not varied without his consent."

The standard one-course concrete pavement will be 16 ft. wide, 7 in. thick at the center, and 5 in. at the sides. The mixture will be 1:5. The fine aggregate will consist of sand or a combination of sand and stone grit. The stone grit is dustless stone screenings of which not more than 25% shall pass a No. 50 sieve and none shall be larger than ⅜ in. in diameter.

The surface of concrete pavements is to be finished by striking off with a steel templet and rolling with a long-handled steel roller, approximately 10 in. in diameter, 6 ft. in length, weighing not more than 100 lb. After the rolling is completed the final finish is obtained by the use of a canvas or rubber belt 12 in. wide. When reinforcement is used, it is placed 2 in. below the surface.

Other Types of Pavements To Be Used

Sheet asphalt will be laid in some instances. This will consist of a 1-in. binder course and 1½-in. wearing course. Specifications for bituminous concrete surfacing include those for Filbertine, Warrenite and Amiesite.

In constructing brick pavements both the sand bed and dry cement-sand bedding methods will be employed. Both grout- and bituminous-filled joints are provided for. Hillside brick are to be used on grades of 5% or more. Specifications have also been prepared for wood-block and stone-block pavements as well as for water-bound and bituminous-treated macadam, but neither of the last two types will be used on new construction of through routes, except under very unusual conditions.

According to Mr. Uhler, the secondary roads or those not a part of the intercounty system can be made to answer every real need—if intelligently maintained—until such future time as traffic and importance justify their absorption as primary routes. It is considered as economical and satisfactory to maintain these in the condition of dirt roads as to pave them with some "obsolete type" of surfacing.

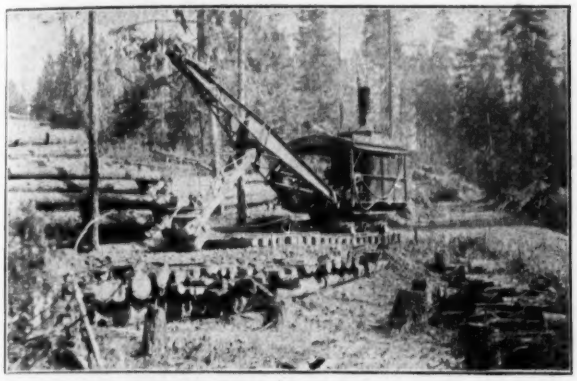
This conclusion, too, is based on extensive experience with earth-road maintenance as well as with bituminous-treated macadam. An earth road can be kept in serviceable and satisfactory condition for at least nine months in the year for $100 to $200 per mile per year, while bituminous-treated macadam is costing now from $500 to $700 per mile per year for unsatisfactory results.

Detroit Does Some of Its Paving Work

In order to utilize more fully its $185,000 asphalt plant, heretofore used only for repairing and repaving its streets, the City of Detroit has recently decided to put down new pavement surfaces. Contracts are still let for excavation, concrete base and curbing, the city confining its work, other than maintenance, to new sheet asphalt, or asphaltic concrete. Thus far five asphaltic-concrete jobs have been undertaken. Before this practice was begun, this asphalt repair plant was worked at only half capacity.

Railway Ditcher Does Grading and Tracklaying

CONSTRUCTION of logging railways in the Northwest is facilitated by the use of a railway ditcher. This is a small revolving steam shovel which travels along a short section of track placed either on the ground or on a flat car. It can be converted into a locomotive crane by removal of the dipper arm and dipper. The accompanying views show a ditcher of this kind, in use as a shovel and as a crane. This machine was built by the American Hoist & Derrick Co., of



DITCHER USED AS STEAM SHOVEL FOR GRADING AND PLACING LOG CRIPBING

St. Paul, Minn., and is shown at work on logging road extensions for the Potlatch Lumber Co., of Deary, Idaho.

The grading is made as inexpensive as possible, and the work is of a rough-and-ready character as compared with ordinary railway work. With the ditcher in use as a steam shovel, and traveling on the ground, as shown in one of the views, it does the grading. The work is left mainly to the judgment of the operator. When the machine cannot reach sufficient material for the required fill, logs are hauled in and cribbed or piled up like cordwood to form the base, as shown. The machine then places earth on top to form a roadbed at the proper elevation.

The machine mounted on a flat car and used as a tracklaying crane is shown in the other view. A car of rails and splice bars is coupled next to the tracklayer, with a car of ties at the rear. Two men on the latter car pile the ties in bundles. The crane picks

DITCHER USED AS TRACKLAYING CRANE

these up in a sling, swings them around and drops them ahead of the machine, where men distribute them on the roadbed. The rails are handled by tongs on the hoisting cable.

The tracklaying gang consists of 16 men, distributed as follows: Two on the tie car putting ties in bundles; 2 on rail car, 1 to place splice bars and the other to attach the rail tongs; 6 distributing ties on the roadbed; 2 laying rails and putting on bridles to hold them to gage; 1 bolting up joints; 1 carrying bridles forward; 2 men on the ditcher.

Behind the train is a gang of 18 men completing the track work; these include 15 spikers, 1 spike peddler and 2 bolters. This crew of 34 men can lay 3000 ft. of track per day, using 60-lb. 33-ft. rails.

Pressure Type Rapid Water Filters Still Have a Place

THE extent of the use of mechanical or rapid sand filters of the pressure type and some reasons for their continued use were brought out by George A. Johnson in the course of a paper on rapid sand filters at the recent convention of the New England Water-Works Association. Mr. Johnson said, in part:

"Pressure filters of the rapid sand type are now operating on municipal supplies in this country in 140 places with a present total population estimated at 1,946,000. The combined capacity of these 140 plants is 257,200,000 gal. daily. The individual plants range in size from 100,000 gal. daily up to the 21,000,000-gal. plant at Atlanta, Ga. Pressure filter plants constitute 20.5% of the total number of municipal rapid sand filter plants in the United States, 10.8% of the total filtering capacity and 10.6% of the total population served.

"The pressure filter was, and still largely is, of stereotyped design. The model pressure filter of today can be fitted with rate controllers and devices for accurately proportioning the dose of coagulant. Everything that can advantageously be built into a gravity filter system is equally applicable in a pressure filter system.

"The pressure filter is particularly adapted to water problems where double pumping would be an important item of expense, since with this type of filter one pumping may be avoided. Along the general line of filter-operating economy it is significant that of all the pressure filter plants operating on municipal supplies in this country more than one-third are owned by private companies. Such companies certainly operate their properties as economically as possible, the first thought of the business man naturally being to furnish satisfactory service at the lowest possible cost. Such operators of pressure filter plants evidently are able to secure good service for less money than would be possible with gravity filters.

"Since water sterilization gained an accredited standing the requirements of water filters, *per se*, have been altered materially. With the realization that cheap and efficient means had been found whereby dangerous bacteria in water could be readily killed, the necessity of relying upon the filter for high bacterial efficiency passed away. The filter is still needed to remove color and turbidity, but sterilization of the physically satisfactory water may be relied upon to insure satisfactory bacterial results."

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

The Engineer Title

Sir—With reference to the letter of Emile Low in your issue of August 23, p. 369, as well as other discussions that have appeared in the technical press recently, in regard to the use of the title "Engineer," it may be well to call attention to a recent pamphlet sent out by the Office of the Chief of Engineers, United States Army, entitled "The United States Needs Skilled Engineers in France." Among the "skilled engineers" needed are listed the following: Bridge carpenters, masons, firemen, concrete foremen, riggers, machinists, clerks, cooks, sawyers, teamsters, drill runners, foundrymen, chauffers, handy men, etc. It would seem from this that the problem of teaching the public the use of the word "engineer" in its proper meaning will necessitate a little home missionary work, for how can we expect a newspaper reporter to use the word correctly when prominent public officials of the profession use it incorrectly?

E. W. ROBINSON,
San Antonio, Tex. McKenzie Construction Co.

The Lucrative Profession—a Protest from Dr. Waddell

Sir—In your issue of Sept. 13, p. 493, there is an article with large headlines which read, "No Promise of Lucrative Practice Made to Engineering Students." This statement is supposed to be based upon a consensus of opinions from a number of prominent engineering educators, obtained by your submitting to them four questions. A perusal of the article caused me seriously to doubt the correctness of your conclusions; and, in order to settle the matter, I have prepared a summary of all the answers to the said questions as reproduced by you. The following are the results of the analysis:

Ninety-one per cent. reported a great demand for graduates in civil, mechanical, electrical, chemical and miscellaneous groups; 9% reported a normal demand and none a small demand.

A dearth of engineers in these larger groups was reported by 72% of those replying, normal conditions by 28% and an over-supply by none.

The war was felt by 85% to have taken an appreciable proportion of engineers; 15% were non-committal and none reported "No."

Thirty per cent. knew of sufficient cases of improvement in engineers' pay and status to support the view that engineering is soon to be the most lucrative of professions; 53% were uncertain or doubtful, and 17% reported "No."

Now, how in the name of common sense can you deduce from such figures the statement in your headlines? The answers to the first three questions are a total contradiction to your deduction. You, therefore, must have based your conclusion entirely on the replies to the last question. Evidently you must have assumed that these uncertain or doubtful answers indorse the stand you took. If so, was that a logical procedure?

In acting as you have done in this matter, you are, in my opinion, assuming a grave responsibility by discouraging attendance at our technical schools—at a time, too, when so much depends upon America's taking the lead in world-reconstruction after peace is declared, to say nothing about the present demand for young trained engineers on the part of the manufacturers of all materials and apparatus needed for the conduct of the war. Six of the leading educators of our country, acting as a committee on behalf of our leading colleges, have combined to urge upon the public, through wide advertising in the press, that young men who have any taste or penchant for that line adopt technics for their lifework, and that they begin their studies at once. Do you wish that the good work which these most prominent and worthy men are doing should be nullified? Possibly not. Your exception was evidently taken to the "Appeal" which I circulated about the end of July in the public press and among the deans and presidents of our technical schools. Perhaps it was presumptuous on my part thus individually to circularize the public and the schools, but the conditions of the times are abnormal and call for unusual procedure. At any rate, my appeal met with wide approval, as was evidenced by calls for more copies of it from all over the country. One man asked for 8000 to circulate in Ohio, and another for 1000 to distribute in the State of Washington. Again, Bishop Thomas J. Shahan, Rector of the Catholic University of America, reprinted the "Appeal" immediately, appended his indorsement and then distributed several thousand copies among the Roman Catholic schools and newspapers of the United States.

Engineering graduates are needed in various ways to carry on the war, to do an enormous amount of reconstruction work soon thereafter and to take care of the demands of both new enterprises and repair work in this country after peace is declared. They are needed also to exploit trade and engineering in all the Latin-American countries, and in China and Russia, so as to extend American influence abroad, with the ultimate object of making the United States the permanent creditor nation of the world and the center of its supplies and manufactures.

To accomplish this great object we must all pull together, and there must be no slackers in this endeavor; for they would be just as harmful to the nation as those other slackers who are opposing the endeavors of the Government to bring the war quickly to a successful close.

J. A. L. WADDELL.
Kansas City.

[Perhaps the use of the phrase, "Visions of a high-paying profession" in the sub-head of the article in question was ill-advised. There is a possibility, also, that question (*d*) was not put in a form likely to draw the type of answer on which definite conclusions could be based; yet, conversely, neither is Dr. Waddell justified in his recapitulation of the relation between questions and answers. As was pointed out in an editorial in the *Engineering News-Record* of June 7, p. 515, "Except in a matter where the elements are simple, clearly defined and not susceptible to varied interpretation, the value of a questionnaire is slight, if not entirely negli-

gible. Strictly speaking, there can never be a consensus of opinion, for opinion is based not merely on facts as they are met with, but so much upon the answerer's previous and disconnected experience, as well as upon tradition, that an attempt to draw an average conclusion is bound to be misleading. It is safe for one to rest on the general principle that questionnaires should not attempt to deal with opinion, but should cover only accomplished fact—that is, things which exist or actions that have been taken.—Editor."]

Engineering Talent in Training Camps Should Be Utilized

Sir—Your editorial in *Engineering News-Record* of Sept. 20, on the exemption of engineering students from military service, emphasizes again a most critical question.

A large number of our engineering students and graduates have enlisted, have gone to the training camps or are now being drafted. Many of these men have been in the training camps for several months. This training is no doubt necessary before they become of military value.

On the other hand, the Government, the railroads and the industries are urging us to recommend men to them for naval construction, for the ordnance department, or for the conduct of transportation and industry. We are unable to suggest men because of the large amount of engineering talent in the training camps. This same talent would be available for Government work immediately if put on a work requiring some engineering training. The engineering world has waited very patiently for the Government to formulate its policy for the utilization of our trained engineering talent to its best advantage, and it seems time that the great engineering societies should offer their suggestions as to how best to conserve our engineering ability and to direct it along lines as immediately productive of results as possible.

R. L. SACKETT,
Dean, School of Engineering,
Pennsylvania State College.

State College, Penn.

Selection of Engineers for Everglades Drainage District

Sir—In your issue of Aug. 23 I notice a communication from George B. Hills, manager for Isham Randolph & Co., entitled "Everglades Drainage District Considered Merits of Engineers." The writer is familiar with the proceedings referred to and he desires to correct a wrong impression given by the article.

Competitive bids for engineering services were received by the supervisors of this drainage district, who stated that the lowest bid received was from Isham Randolph & Co., represented by S. W. Randolph, according to the terms of which proposition Isham Randolph & Co. proposed to serve as both chief engineer and consulting engineer for the district for a fee of $250 per month, and that bids from other engineers ranged from $5000 to $11,000 per year for services as chief engineer only. I quote from a published letter of the supervisors:

"July 14, we appointed Isham Randolph & Co. as consulting engineers of the district at a salary of $250 a month. Isham Randolph & Co. are, without question, the leading drainage engineers of America and have been connected with practically every reclamation project of any prominence that has been undertaken in this country for a number of years past."

Mr. Hills states that "the selection of engineers for the district was not made on the basis of competitive bids, but was made after the district had thoroughly considered the merits of different firms *according to their own views.*" It is not clear whether he means the views of the engineers or the views of the board of supervisors, but in either event this qualification is highly significant.

It is natural to assume that engineering merit is in all cases the criterion according to which engineers are selected for public work. This assumption is based upon the most generally accepted principles of economics and requires no argument. Neither does professional greatness and supremacy require argumentative and self-proclaimed praise.

V. W. HELM,
President, Everglades Sugar and Land Co.

Miami, Fla.

Road Maintenance in the War Zone of France

Sir—An article of more absorbing interest than that by William J. Weir on "Road Maintenance in the War Zone of France," in your issue of Sept. 13, page 488, has seldom appeared in any technical publication. The writer of this article, with a literary skill too rarely found in the writings of engineers, has drawn a brilliant picture of conditions in the war zone as he observed them, particularly as to the road-maintenance work that he encountered.

As complete as this article appears, it does not seem that one would be justified, from the actual facts disclosed, in drawing from it any very definite conclusions involving basic road economics. From what the writer of the article himself states, and from known facts not stated in the article, it does not seem possible to arrive at the deduction made in your editorial in the same issue, that a macadam road, or any other particular type of road, is best for war traffic.

Mr. Weir writes that the French roads were of but one type—macadam. He states that he had occasion to see the roads only at times when weather conditions were most favorable, but the chief point, on which the article is silent, is the effort that was necessary to keep these roads in any way serviceable under the war traffic. There is no intimation as to how many men were necessary per mile for the minute-by-minute maintenance. The writer, however, has been informed that one thousand, two thousand and even a greater number of men per mile have been found necessary to keep the roads in even a passable condition while under the stress of war traffic.

The number of vehicles which it is stated used these roads is extraordinary but not unprecedented. There is nothing to indicate, nor can one conceive, that a rush of vehicles in war time has any greatly different effect on a road surface than a similar rush of vehicles would

have in peace time. By far the greater mileage of French roads under war traffic is not within the shelled zone, yet, because of the effect of the traffic alone, they have required the most extraordinary efforts to keep them day by day in a condition to take care of the traffic.

Therefore, far from concluding from Mr. Weir's article that macadam roads are best in war time, it would be much more reasonable to suppose that had the French roads been constructed in a more durable manner they would have given far better service and would have required but a small fraction of the number of men that has been found necessary to keep them in even passable shape. This saving in man power might even be a factor in the ultimate result. Surely there is no evidence of such remarkable efficiency on the part of the macadam road that one is warranted in drawing the conclusion that "macadam roads are best for war traffic."

A. R. HIRST,
State Highway Engineer of Wisconsin.
Madison, Wis.

Sir—I have read with great interest Mr. Weir's article on "Road Maintenance in the War Zone of France," also your editorial entitled "Macadam Roads Best for War Traffic," appearing in the issue for Sept. 13, page 488.

Mr. Weir's observations are interesting and instructive, particularly because of his former connection with the Office of Public Roads. That they should be used as a basis for conclusions as to the "best type of road for war traffic" is hardly conceivable. In the first place, comparison between macadam and other types is impossible because no other types were observed. This is evident from his statement that "no bituminous macadam, concrete, brick or any of our American so-called permanent types were encountered." Even the macadam roads were observed during only a part of the year for, again quoting Mr. Weir, "the severe test of this type (macadam) would, of course, come in the summer when the wear due to loss of binder in the wind and to raveling must be very great. Unfortunately, I was not in the war zone during that period and so cannot judge." One can imagine no more serious objection to macadam than the ever-present cloud of dust which envelops vehicles when the road is under constant use in dry weather.

To be selected as "best for war traffic" the macadam road must have merits which outweigh the objections to it and be preëminently superior to all other types. Has the case for macadam been proved? It is true that these roads been kept in usable condition by constant and expensive maintenance, but who would question the ability of French road engineers to solve this problem on concrete roads? In considering this question we must assume that the concrete road would be built to the same standard as the French macadam road. This would not mean a "6-in. concrete" as mentioned by Mr. Weir, for no road engineer would think of using such a thin slab on a road having 33 ft. of metal.

With foundation and drainage such as we find under all main roads in France, I have no hesitancy in asserting that the entire maintenance repairs of a concrete road under similar traffic could be taken care of with tar and sand. Such repairs are quickly made and necessitate no delay to traffic. This assertion is made on the basis of performance of concrete roads which have been in service for ten years under heavy traffic.

Even if the above were not true and the repair of macadam roads were the simplest problem, there still remains the following advantages of concrete for war-traffic roads:

Less tractive effort required and, therefore, less gasoline and oil. (About one-third of that for macadam. See Prof. J. B. Davidson's results in your issue of Aug. 23); less wear and tear on tires; less wear and tear on machinery; greater speed possible; equally satisfactory in good weather and bad; no clouds of dust in dry weather.

Engineering News-Record might well set a good example to the American engineer who is prone to draw conclusions from incomplete data by modifying the conclusions drawn from this article of Mr. Weir's.

WILLIAM M. KINNEY,
Engineer, Promotion Bureau, Universal
Chicago. Portland Cement Co.

Concrete Must Be Well Worked

Sir—I have noted several recent references to the compacting of fresh concrete in roads by rolling it. In view of my experience, that there cannot be too much working of concrete in the process of mixing and placing, I would recommend to your interested readers the roller treatment or any other method of thoroughly tamping.

Nearly all the little troubles noted during the construction of the aqueduct of the Greater Winnipeg Water District can be and have been cured by the general prescription, WORK!

Mixing for two minutes is required by our specifications. Too much water is not approved, although there is a great temptation to contractors to supply in the mixture enough water to make the concrete slide easily. The proper proportions of water require therefore a little more of work in the act of placing and tamping the concrete into the forms.

With a wet mixture we find a considerable settlement of the solid material and a corresponding upward flow of excess water which washes certain portions of the fines with it. The settlement occurs vertically and from the crown of our aqueduct it is necessary to force the concrete materials over the curve of the arch down into the walls and to make up the consequent deficiency of the materials upon the crown and for a period extending until the concrete in the crown by the process of setting becomes too stiff to work. I appreciate that this last specification is contrary to the usually accepted theory, that concrete should not be disturbed during or after the initial set of the cement.

Whether it be in the manufacture of road pavements, in the construction of foundations, in the manufacture of water-tight concrete structures, or in the prevention of segregation, on a large or small scale, too much working cannot be given to the raw concrete. Manufacture of good concrete is not a job for an unintelligent workman, nor for an indifferent foreman, nor for a lazy, selfish or cheap contractor, nor yet for an easily satisfied inspector or engineer. W. G. CHACE,

Chief Engineer, Greater Winnipeg Water District.
Winnipeg, Man.

THE ENGINEER IN FIELD AND OFFICE

A DEPARTMENT DEVOTED TO DETAILS OF THE DAY'S WORK

Salvaged Steel Shows a Saving of 75 Per Cent

BECAUSE of the scarcity and high price of reinforcing steel, it was decided to attempt a recovery of as much as possible of the steel originally used in one of the several bridges destroyed in North Carolina during the July floods of 1916. The particular instance was a concrete structure over the Catawba River at Sloan's Ferry, a photograph taken immediately after the flood being shown herewith.

NEGROES WITH SLEDGE HAMMERS RECOVERED 100,000 POUNDS OF STEEL FROM THE WRECKED SPANS AT A COST OF ONE AND ONE-QUARTER CENTS PER POUND

Under the personal supervision of George N. Syme, division engineer of the North Carolina State Highway Department, a gang of negro laborers broke up the concrete with sledge hammers. Dynamite was used only sparingly, since it merely made a small hole in the slab which could be used only as a starting point for the sledge-hammer crew.

By this means a total of about 100,000 lb. of steel was recovered, cleaned, straightened and stacked at a total cost of $1250, or 1¼c. per pound. This is not more than 25% of what new steel would have cost delivered at this work. The salvage was accomplished entirely on the approach spans, which were of the beam and slab type of construction, and were high and dry at all ordinary stages of the river. No attempt was made to break up the channel span.

The structure will be replaced with one of similar design, using the old pier foundations which, with one exception, are still in perfect condition.

Ruling with Common Ink Saves Time

IN MAKING scale sketches on desk designing sheets for direct tracing by the draftsman, one engineer finds it a great convenience to use ordinary, in place of india, ink. This requires a german-silver ruling-pen, such as is made for bookkeepers' use. A time saving results from the fact that when the pen is laid aside with its ink filling it will not dry out, but will be ready for instant use even after a quarter or half an hour.

Drawing the sketches in ink, rather than pencil, is far easier for the tracer as well as being safer against errors in tracing. The method applies to a great many parts or objects of such simple character (or to be shown so generally) that no fuller detailing is needed than the designer's sketch contains. However, lines as fine as may be desired may be drawn.

Concrete-Road Problems Recommended for Student Research

SEVEN subjects for student-thesis research have been recommended to American technical schools by A. N. Johnson, consulting highway engineer of the Portland Cement Association, Chicago. All bear on problems of concrete road work and the list is the outcome of requests by educators for topics of practical value and live interest.

(1) *Methods and Effect of Various Ways of Finishing Concrete Pavements*—The various methods of finish-

ing concrete pavements are of vital interest since the strength of the resulting concrete may be greatly modified by the manipulation which it receives. The evenness of the surface is also of great importance. A method which has a tendency to form transverse waves is evidently not desirable. Investigate what degree of evenness may be reasonably expected, and to what extent various degrees of unevenness of the surface affect the comfort of traffic.

(2) *Various Factors That Influence the Making of Good Concrete.*

(3) *Methods To Determine the Wear of Concrete Pavements.*

(4) *Methods To Determine the Relative Value of Various Aggregates for Use in Concrete Pavements*—Subjects 3 and 4 are somewhat interrelated, although they may be treated separately.

(5) *Effect of Frost Action on Road and Pavement Design*—There has been but little investigation as to the effect of frost upon soils, at least in so far as this has a bearing on the design of pavements—particularly the rigid and rigid-base types. Drainage has been provided, usually in an empirical way, but no designs have been based upon actual knowledge.

(6) *Investigation of Pavement Temperatures*—The action of pavements under varying temperature and moisture conditions calls for much careful study. It will be necessary to develop a method which would give reliable information as to the temperature gradient from the air immediately above the pavement to the soil at the base. This might well be a separate study by itself.

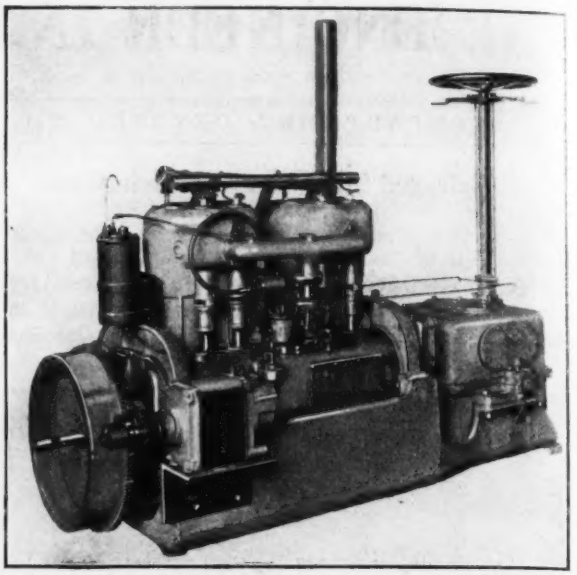
(7) *Equipment Required for Concrete Paving Work*—There has been no paper or committee report dealing comprehensively with this phase of concrete-road work. Any collection of accurate data will be valuable, however incomplete it may be. The data should endeavor to give an outline of the conditions under which the work was constructed so that it would be apparent why it was necessary to use any peculiar equipment or arrangement of equipment.

Gasoline Motor Actuates Movable Bridges

SINCE the power to operate movable bridges is required only intermittently, and as two independent sources of supply are usually required on large railroad bridges, it is argued that the light high-speed automobile engine, occupying but a little space, particularly lends itself to this class of work. Furthermore, its ease of starting and its present-day reliability give it an advantage over slow-speed engines.

Where these engines have been used they have usually been connected through a clutch and reduction gearing to the operating machinery. When operating only as auxiliaries, they are geared down to open the bridge at one-fifth to one-twelfth the speed obtainable with the main power.

All engines over 40 hp. are provided with heavy flywheels, governors and self-starters. Under 40 hp. they can be readily started by hand. The illustration shows a 50-hp. 900-r.p.m. engine and reversing clutch mounted on a sub-base. The engine is started by a 110-volt d.-c. motor, which is automatically thrown out when the engine gets up to speed. The vacuum system of



GASOLINE MOTOR AUXILIARY ON 450-FOOT DRAWSPAN

gasoline feed is used. The reversing clutch, in an oil bath, operates through bevel gears and is thrown in and out, and reversed, by the handwheel on top of the gear case. This engine is used as an auxiliary on the 450-ft. double-track drawbridge over the Missouri River at Kansas City on the line of the Chicago, Burlington & Quincy Railroad.

C. H. Norwood, contracting engineer, Chicago, who has given much attention to the development of this phase of movable bridge operation, is responsible for this, as well as several other similar installations.

New Water-Sample Shipping Case

A SHIPPING CASE holding eight 4-oz. water-sample bottles and having an ice capacity to maintain a temperature of 10° C. for 48 hours is described by R. R. Spencer, assistant surgeon, and H. P. Setton, sanitary engineer, U. S. Public Health Service, in *Public Health Reports* for Sept. 14, 1917.

The case is of 20-gage galvanized iron, 8 in. wide, 15 in. long and 13 in. high, outside dimensions. It is insulated with 1 in. of pressed corkboard and lined with 24-gage galvanized iron, which makes a water-tight joint with the outer casing. The case has two covers: (1) An insulated cover, which has a tapered edge so it will drop easily into place, and a flange to support it; (2) A protecting cover of 22-gage galvanized iron, strengthened at the edge with wire, and provided with hinges and a padlock hasp. The case is carried by means of a rope handle, secured to strap iron eyelets riveted to the sides of the case. The container for the sample bottles is a can 5 in. in diameter and 10 in. high, made of 26-gage galvanized iron, and provided with a slip cover 2-in. deep. The can is held in place by a galvanized iron bond attached just above midheight. The space around the can will hold 13 lb. of ice. If desired, a liter bottle can be packed in the can instead of eight 4-oz. bottles. The cost of 25 of these cases complete was $6.50 each in 1915, and $8 in 1917, the increase being due to the rise in the price of galvanized iron.

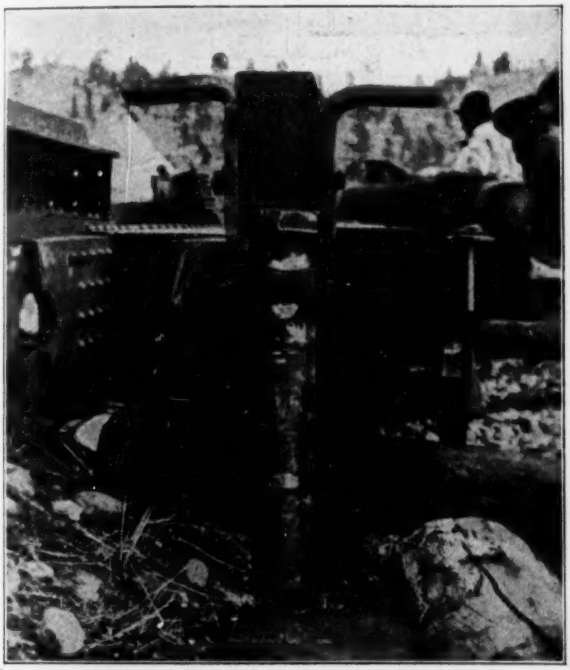
HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Pull Bridge Pins with Jacking Grip Engaging Nut

By E. S. Needham
Livingston, Montana

THE DEVICE shown in the photograph was used in removing the pins from an old truss bridge on the Northern Pacific Ry. In using it the nut on one end of the pin is unscrewed just enough to allow the short bent ends of the bars to slip under it. Two jacks bearing against the chord member are used to extract the pin.



GRIP ENABLES SMALL JACKS TO PULL PIN

The wood block between the bent bars keeps them apart, but it has been suggested that a more solid arrangement could be made by riveting a straight bar across the top. The work on which the device was used was carried out by McCreary & Willard, of Spokane, Washington.

Turns Side-Discharge Mixer Around To Grout Pavement

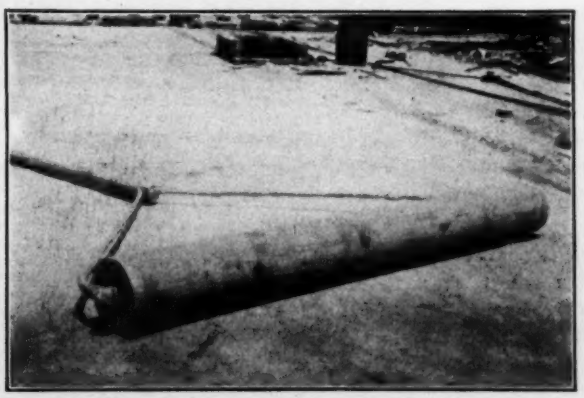
THE PHOTOGRAPH shows how George Czerwinski, a paving contractor of Milwaukee, converted a 4-ft. Rex mixer from a side loader into an end-loading machine for grouting pavement. The advantage, of course, is that the mixer can be pulled along the street as the work progresses, and will still discharge directly to the rear where the grout is wanted. As may be seen from the picture, the change was accomplished by taking the wheels off the mixer putting them on a new pair of

MIXER TURNED AROUND ON ITS TRUCK FOR PAVING WORK

axles, and clamping the old mixer frame with axles at right angles to the new ones. This, of course, simply brought the loading platform to the front of the carriage, and the discharge to the rear. The machine is reported to be working in a first-rate manner.

Apply Hose and Roller Finishing Method to Roof 120 Feet Wide

THE METHOD of finishing concrete roads with a long-handled roller and a piece of rubber hose, developed in Georgia and described in the *Engineering Record* of Nov. 4, 1916, p. 572, is being applied successfully to finishing roof slabs 120-ft. wide on the last units of the Atlanta Warehouse, which was described in last week's issue, p. 654. The main difficulty developed was to secure a light enough roller to leave an even surface after pressing in the aggregate and bringing the mortar to the surface. The 8-ft. roller shown in the photograph is made of narrow 1-in. wood strips nailed to three transverse 5-in. diameter drums of 1-in.



LONG-HANDLED ROLLER USED TO FINISH ROOF

plank, the whole being covered with galvanized iron. Through its center passes a 1-in. round rod, the ends of which are bent back, flattened and bolted to a 20-ft. wood handle turned round from a 2 x 4 piece. The runways are taken up, and the roof slab just poured is rolled with this tool. Next a rubber hose 140 ft. long is draped clear across the ridge of the roof and dragged from end to end of the section by two men walking at the edges of the roof. Although the dragging length of hose is more than 120 ft. between ends and passes across a ridge at the center of the roof, there is no tendency to cut into the soft concrete of the ridge and an even finish is secured. The cost, naturally, is far less than with the trowel and float method used on the first units. No coating or other finish is given the roof. The pitch, while slight, insures quick drainage, and no leaks have developed.

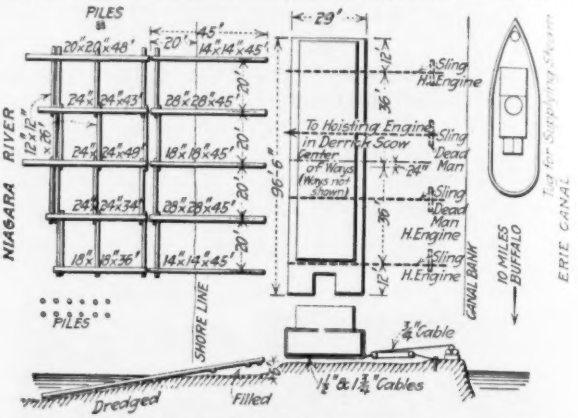
The work is being done by Arthur Tufts, contracting engineer, of Atlanta. E. A. Stuhrman is designing engineer and C. R. Justi is in charge of the work in the field.

Pull 525-Ton Dredge Up River Bank and Launch Into Canal

By Emile Low
U. S. Assistant Engineer, Buffalo

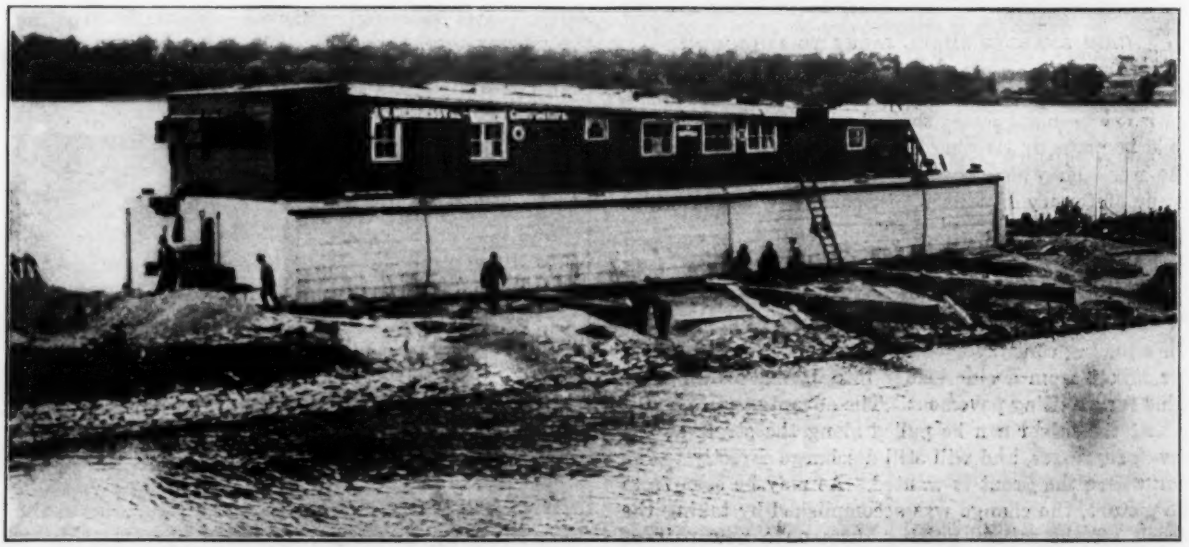
THE HYDRAULIC dredge "Niagara," the displacement of which is 525 tons, after being dragged bodily up timber ways over the bank separating the Niagara River from the Erie Canal was launched into the latter on Sept. 5 last. Originally built in North Tonawanda and used in dredging a section of the Barge Canal between Tonawanda and Lockport (see *Engineering News*, Apr. 10, 1913, p. 717), this dredge was sold on the completion of the contract for work at Hamilton, Ont. It was gotten out of the canal into the Niagara River during the closed season for navigation by taking it through a gap cut in the bank between the river and the canal after the level of the latter had been drawn down. This procedure was resorted to because the size of the dredge, 96 ft. 6 in. by 29 ft., forbade taking it through the old Erie Canal locks, which are only 18 ft. wide. It could not be repeated when the same dredge was repurchased by the Empire Engineering Co. for additional work on the same section of the canal, because the contract was let during the summer and it was not possible to wait until the navigation season closed before starting work.

The water level in the Niagara River at the point where it was decided to take the dredge into the canal is



PREFARATIONS, INCLUDING GRADING FOR WAYS, CARRIED OUT AND TRANSFER OF DREDGE TO CANAL COMPLETED IN TWO MONTHS

about 6 ft. below the latter. A survey of the site was made and timber ways designed as shown in the drawing, up which the dredge could be pulled by hoisting engines to the top of the bank. It was necessary to excavate along the shore of the river in order to place these ways, and to make a fill of about 6 ft. in part of the river bank. The material to be handled, a very hard clay, proved too stiff for a derrick scow with an orange peel bucket, and a dipper dredge was called in to do the work. As soon as the excavation was finished 12 x 12 timbers were laid down and the ways placed on them. The dredge was floated in and four slings of 1½- and 1¾-in. wire cable passed around the hull. Three-fourths-inch wire rope falls of three and four parts were



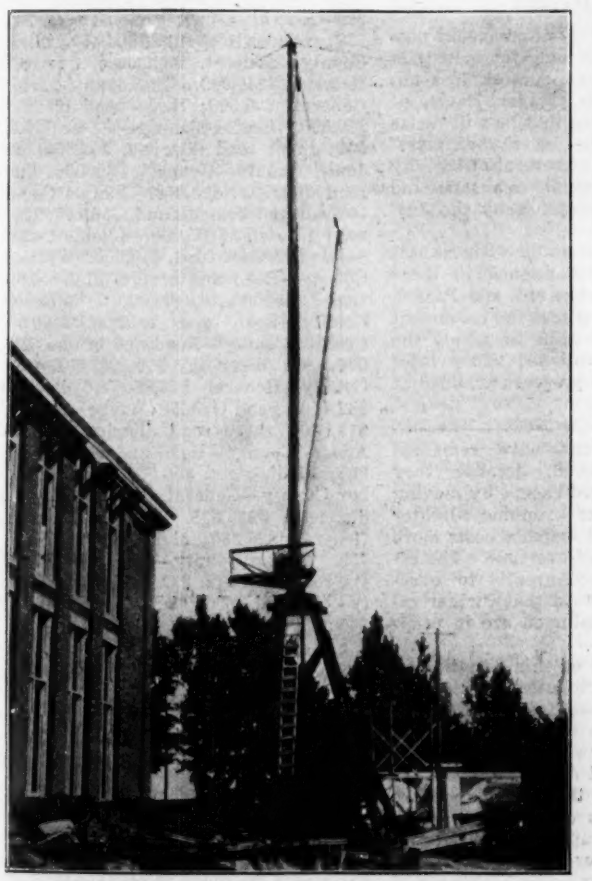
BIG DREDGE TO BE LAUNCHED INTO CANAL ON NEAR SIDE WAS HAULED OUT OF RIVER BY FOUR HOISTS

fastened between these slings and deadmen at the top of the bank, the lead lines passing to three hoisting engines anchored to these deadmen and one hoist on the deck of the derrick scow. The hoists on the bank were 8 x 10 in., while that on the derrick scow was a 10 x 12. Steam was furnished to the three hoists on the bank by a tug anchored in the canal.

After the scow had been pulled to the top of the bank, the ways were rearranged and the dredge launched into the canal in the usual way. This was accomplished Sept. 5 last, about two months having been occupied in making the transfer. The work was done under the direction of F. W. Allan, superintendent for the Empire Enginering Co., the contractor.

Derrick Mounted on Tower Erects Lumber in Mill Construction

THE PHOTOGRAPH shows a type of derrick which has proved very useful in constructing Southern cotton mills of the slow-burning brick wall, timber frame and floor construction. These mills, which can be erected very rapidly, are generally rectangular structures about 100 ft. wide, 500 ft. or more in length, and two or three stories high. In the method of constructing these followed by the F. E. Thompson Brothers Co., contractors, Charlotte, N. C., these long-boom derricks mounted on a high four-legged tower play an important part. The platform for the operator is at the top of the tower and is high enough for him to see over the roof of the structure. Lumber and other construction material are transferred directly from wagons to the upper floors or roof by the derrick operator. The materials are then distributed throughout the length of the structure by two-wheeled man-operated trucks on temporary runways or on the completed sections of floor or roof.



OPERATOR CAN SEE OVER BUILDING

Float with Pole Handle Makes Finishing Easy

By James A. Cain
Wilkinsburg, Penn.

BY RAISING and dipping the handle of the float shown in the photograph while sliding it to and from the user a smooth surface can be secured on a concrete base for road work at a rate exceeding 5000 sq.ft. per 10-hr. day. The float is made from a block of 2-in. plank 18 in. long and 12 in. wide. A handle made from a 2-in. sapling is cleated to this block. On paving construction in Pittsburgh, supervised by Douglass & McKnight, where the writer used this float for J. I. Dick, contractor, of Scottdale, Penn., one man was easily able to finish 250 lin.ft. of concrete base on a roadway 21 ft. wide in ten hours.

MAN FINISHES NINETEEN SQUARE YARDS AN HOUR

Evanston Rapid Filters Are Raked

Once a week the water is drawn off the rapid sand filter beds of the water-works of Evanston, Ill., and the surface of the beds inspected. If needed, said John W. Gaitenby, superintendent of filtration, in a paper read at the recent convention of the New England Water-Works Association, the surface of the beds is raked and cross-raked and at the same time lightly washed. The beds are then washed with two or three times the regular amount of wash water, sprinkled with chloride of lime and again washed before being put in service.

NEWS OF THE WEEK

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Release Labor for War Work by Consuming Less

Country Is Trying To Do More Work Than There Is Labor To Do It With

After a careful study of the labor situation, the *Bulletin* of the National City Bank of New York has this to say in its October issue:

"The situation is disquieting in all parts of the country, and but for the good crop yield it would be alarming. It is not surprising that with high prices prevalent on all sides wage earners should claim more pay, but the disquieting thing is that higher wages mean still higher prices, and thus we travel in a circle. At last the explanation is that the country is trying to do more work than there is labor to do it with.

"A vast amount of work is being done under rush conditions for the Government, and the contractors have offered wages that would bring labor out of the regular industries. Sixteen cantonments have been built in different parts of the country at a cost of $150,000,000, in three months, and about 8000 to 10,000 workmen have been employed on each. The influence of this upon the labor situation has been widespread. Numerous shipyards are under construction, steel works and munition plants are crowded with orders and hundreds of new coal mines are struggling to get a share of the labor supply. The point has been reached where it is a serious question whether any further construction work should be done unless directly required by the war emergency. Where is the use in enlarging capacity when the present capacity of the industries cannot be manned? It may seem to an individual that he can enlarge his business profitably, but if he can only operate the new capacity by hiring labor away from other equally important work there is no gain, and the entire level of costs is being constantly raised by this process. The real remedy all around is indicated by the high wages and prices; it is for the public to curtail consumption, in order that labor may be relased for the war work.

"The United States Steel Corporation has led off with another wage advance of 10%, and the other steel companies are following. The coal miners, with whom a liberal settlement was made in April, are insisting upon another advance. In the textile industries of New England a movement is on for a further round advance in wages.

"The railway trainmen achieved a great victory last March by establishing the unit eight-hour day in train service. Train runs have remained practically unchanged, because they could not be changed except by moving division points or running lighter trains, which would increase costs more than the payment of overtime. The effect has been to add greatly to 'overtime.' It is understood that further requests from the trainmen are in preparation.

"The final effect of this situation in the manufacturing industries is to constantly attract labor from the farms, thus curtailing the food supply. It is evident that at some point in this circle an influence should develop for the return of workers to the farms. Raising wages in the cities will never compensate for declining supplies of foodstuffs, if the higher wages continue to draw labor from the farms."

Course on Ports and Terminals Offered by Columbia

A special course of lectures on the planning and equipment of ports and harbors is offered this year by Columbia University, under the direction of Dr. R. F. MacElwee, department of economics. The course, which consists mainly of lectures, will be given at the downtown rooms of the School of Business, 203 Broadway, Mondays from 5:10 to 6:50 p.m. during the winter, 1917—that is, from October to February. There will be 30 lectures in the course. The object of the course is to lay down the principles underlying the work which a port must perform as a coördinated and assembled piece of machinery; then to take up in detail each of the various parts and its relation to the whole. While the mechanical and engineering details will be emphasized, great attention will be given to the economic side of the port handling question.

Coal Situation Becomes Critical in Cleveland

If after using every other means possible to get coal not only for industries but for domestic use, success does not attend such efforts, Mayor Davis, of Cleveland, announces that he will "seize every ounce of coal in the vicinity." The supply of coal at several of the city institutions is practically exhausted and the shortage is being felt by the citizens.

The Cleveland situation with respect to coal has been mentioned in these columns Aug. 23, page 381, and June 7, page 522, in which places the movement to purchase a coal mine to supply the city needs was mentioned and a brief record made of the progress attained at those dates.

Washington State Highways To Spend $9,000,000

Budget for 1918 Shows Much Work Will Be Undertaken—Not all Counties Heard From

The annual budget compiled by the various counties in the State of Washington for 1918 show a gratifying sum set aside for highway construction work, which, taken together with the sum of $1,500,000 to be expended by the State Highway Commission on road work next year, shows a probable total of $9,000,000 available. The counties reporting to date are as follows:

Snohomish County—Bond issue roads, $750,000; general road and bridge fund, $105,000; three road district funds, $150,000. Clallam County—General road and bridge fund, $60,000; four road district funds, $88,000. Clarke County—General road and bridge, $60,400; three road districts, $88,700. Lewis County—General road and bridge, $84,250; road districts, $174,000. Grant County—General, $45,000; nineteen road districts, $80,000. Franklin County—General, $9000; gravel roads, $44,750; road district fund, $54,400. Pierce County—General, $300,000; five road districts, $240,000. Okanogan County—General, $36,500; three road districts, $19,000. Benton County—General, $52,000; three road districts, $57,600; San Juan County—General, $6000; three road districts, $13,650. Skagit County—Road and bridge fund, $56,135; three road districts, $105,000. Chelan County—Road district fund, $10,000. Whitman County—Road and bridge, $135,000; 13 road districts, $164,000. Whatcom County—Road and bridge, $100.000 Cowlitz County—Road and bridge, $37,000; six districts, $79,200. Douglas County—General, $46,880; 16 districts, $82,450. Pend Orielle County—General, $18,000; three road districts, $34,000. Adams County—Road and bridge, $79,500; 16 districts, $56,500. Grays Harbor County—General, $95,000; six road districts, $225,535. Mason County—General, $23,250; eight districts, $49,735. Kitsap County—General, $27,850; six road districts, $37,170. King County—General, $350,000; three districts, $650,000; bond roads, $400,000.

Fifteen counties have yet to be heard from, but will probably average about $25,000 each.

Public Health Association Meets October 17-20

The date of the meeting of the American Public Health Association at Washington, D. C., is Oct. 17 to 20, instead of Oct. 20 to 27, as erroneously announced in these columns last week.

Ordnance Department Needs Many Inspectors

Executive Ability and Experience in Manufacturing Desirable—Draftsmen Called For

The Ordnance Department of the army is in urgent need of inspectors of ordnance equipment at salaries ranging from $1500 to $2400 a year. Men of good education are wanted, since they will have to superintend the work of a force of assistant inspectors and prepare reports of the inspection, shipment and payment for articles inspected. The bulk of the materials inspected will consist of manufactures of leather, such as saddles, bridles, etc.; of duck and webbing, such as belts and pouches; and of metal, such as meat cans, canteens, cutlery and intrenching tools. Applicants must have the education and experience called for in one of the following groups:

(a) Graduation from a college or university of recognized standing and one year's experience in a manufacturing plant producing articles described above, or in a related industry.

(b) Graduation from a college or university of recognized standing and two years' experience in a responsible executive position in any producing industry or in an industry requiring the handling of stores and materials.

(c) Graduation from a college or university of recognized standing and three years' service in the United States Army, Navy, Marine Corps or National Guard.

(d) Graduation from a four years' high-school course, or four full years of study in a school offering a course equivalent to that of a high school, or graduation from a well-established trade school fitting its graduates for higher positions in manufacturing lines producing articles similar to those described above; and, in addition, four years' experience in a manufacturing plant producing articles described above, or similar experience in a related industry.

EXECUTIVE ABILITY WANTED

Applicants should submit evidence of executive ability, together with a definite and detailed statement of all the experience they have had. Additional credit will be given to those familiar with the best practices in connection with the manufacture of the articles named above, and to those experienced in the employment and handling of men and in keeping records. Applicants must be 23 years old at the time of making application.

The Ordnance Department is also short of assistant inspectors. Assistant inspectors of cloth equipment are wanted particularly, at salaries ranging from $1000 to $2000. Applicants should have completed a two years' textile course in a textile school or recognized college, or must have had at least one year's experience in the inspection and manufacture of articles made from cotton stuffs, or they must be discharged soldiers with the rank of company quartermaster sergeant or higher.

There is, of course, the perennial demand for mechanical draftsmen. The work of the Ordnance Department is seriously hampered by the lack of applicants for such positions. There are two grades, the first paying from $800 to $1400, and the second from $1400 to $1800. Applicants for the higher grade must have a college degree and two years' drafting-room experience, or the degree of mechanical engineer with one year's experience in the drafting room, or the completion of two years in a mechanical engineering course and three years' experienec as a draftsman.

For the lower grade, senior students in a mechanical engineering course without practical experience or college graduates who have had six months' drafting-room experience will be accepted. All "red tape" has been dispensed with. Applicants are required merely to fill out the application form which contains space for a complete statement of education and experience. Appointments usually are made in from one to three weeks' time. In the case of draftsmen, a sample of work must accompany the application. At the request of the Ordnance Department, the National Civil Service Reform League, located at 79 Wall St., New York City, is answering inquiries concerning these positions and will furnish application blanks on request.

Columbia River Highway Bridge Is Paying Well

The interstate bridge between Oregon and Washington over the Columbia River at Vancouver, Wash., has now been in service about six months and the travel over the structure, as indicated by the toll receipts, has far surpassed expectations. The present rate makes the bridge more than self-supporting, and, in fact, if the present conditions continue, it will pay for itself in a few years. The income since the bridge was thrown open to traffic has been as follows:

	Electric Railway Tolls	Vehicle Tolls	Total
February	$1,702 76	$2,019 84	$3,722 60
March	3,518 91	4,472 74	7,991 65
April	5,011 13	6,218 11	11,229 24
May	4,605 58	7,066 75	11,672 33
June	4,930 97	9,308 60	14,239 57
July	5,925 84	11,426 87	17,352 71
Totals	$25,695 19	$40,512 91	$66,208 10

The location of the Government training camp for engineer troops at Vancouver, Wash., has notably increased traffic over the bridge. It is notable also that much freight now goes by motor truck which could not be sent by that means when the ferry had to be relied upon. The average day's receipts have been $396, and the highest $837, which was taken in on July 4. The average daily operating expense is $57.62. The bridge was described in the *Engineering Record* of July 8, 1916, p. 36, and *Engineering News*, Mar. 29, 1917, p. 530.

Oppose Special Commission To Build Subway

Cleveland Engineers Feel That Study by City Planning Board Is Sufficient Now

The executive board of the Cleveland Engineering Society has declared against the Rapid Transit Commission ordinance which is to be voted on at the coming election in November. The declaration came with the adoption of an adverse report of a special committee on the plan of proceeding to develop a subway system by a commission to be appointed under legislative enactment. While members of the committee were not opposed to the building of subways, they assert that the time is ripe only for a complete study of all phases of the problem, and attention is called to the city charter provisions which authorize the city planning commission to make such a study.

Until a report by the city planning commission is made, and the public is fully acquainted with the proposed improvements, the engineering society's position is that there is no need to appoint a commission for constructing subways. Questions of subways, location and size of streets and main traffic arteries are held to be functions within the jurisdiction of the planning commission. It was pointed out that when such a study has been completed and plans have been approved by the city, no part of the subway should be built unless it is an integral part of the general scheme of relieving traffic congestion.

Testing Materials Society Adopts New Specifications

The letter ballot of the American Society for Testing Materials on the amendment of the by-laws and the adoption of four new standards was canvassed on Aug. 15 by a committee of tellers consisting of W. H. Fulweiler and L. H. Kenney, who have reported the following results:

	Aye	Nay	Not Voting
Proposed Amendment of the By-Laws:			
Article II, Section 3	322	0	74
Article III, Section 2	322	0	74
Proposed New Standards			
Tests for:			
1. Paint Thinners other than Turpentine	113	3	280
2. Shellac	101	2	293
Methods for:			
3. Routine Analysis of White Pigments (as amended at annual meeting)	104	2	290
4. Sampling and Analysis of Creosote Oil	92	15	289
Total number of legal votes cast			396

The four new standards included in the above ballot are accordingly effective from Aug. 15, 1917, and bring the total number of standards adopted by the society to 107.

The proceedings of the recent annual meeting (Vol. XXVII) will be issued shortly in two parts, as usual. Part I will be devoted to the committee reports and tentative standards, and Part II to the technical papers. It is expected that they will be distributed early in November.

Chicago-Milwaukee Hard Road Seems Assured

Early completion of the new hard road between Chicago and Milwaukee seems assured since state and Federal aid to the extent of $400,000 has been allotted to Cook and Lake Counties, without definite apportionment to either, for constructing a 24-mile stretch from Chicago to the Wisconsin state line. Contracts have been let for the Wisconsin section.

The portion through Lake County is along the lake shore and does not benefit directly a large number of the property owners in the central and western areas. By mutual agreement between the county boards Lake County's portion of the $400,000 is to be $325,000 to apply on 14 of the total 24 miles. This will permit the county in an issue of $500,000 to build a much-needed east and west connecting road. These bonds will be voted upon Oct. 30.

Cook County has expended practically all of the $2,000,000 issue from which the last two seasons' mileage has been constructed. Several small links totaling 49 miles are missing in the system already started, most of which can be completed with a $1,000,000 issue. The voters in Cook County will be asked for this amount in the November election. Of those now under consideration, in addition to the Chicago-Milwaukee road, the most important are 12 miles on the southwest outlet toward Joliet on the designated Federal-aid Chicago, Springfield and St. Louis route, and 9 miles to complete the Lincoln Highway west of Chicago Heights. Estimates of $22,000 a mile are being made, based on the cost of $19,900 per mile for 33½ miles of 18 ft. widths built and under construction in 1916 and 1917.

Cleveland To Vote on $3,000,000 Sewer Bonds

On Sept. 25 the Cleveland City Council adopted a resolution submitting a $3,000,000 sewer bond proposal to the electors of Cleveland at the election Nov. 6. This proposal was adopted without debate as was a similar one to provide $1,000,000 in hospital bonds.

Robert Hoffman, chief engineer of the Public Service Department, reports that many of the old sewers of the city are inadequate and that several million dollars could be expended to advantage on such work.

National Old Trails Road Dedicated

The first paved section of the National Old Trails Road was dedicated in Marion County, Indiana, on Sept. 15. This section of the old and historic national road extends from the county line at Cumberland west to the city limits of Indianapolis, a distance of nearly 6 miles. It is paved with concrete. The next section to be paved extends west from the city to the county line near Bridgeport. The dedication was arranged by the Marion County Commissioners and Charles E. Cheney, county surveyor, who has charge of the road work. Apart from the addresses of officials and invited guests, the ceremonies included a parade through the city and a trip over the 60-mile system of hard-surfaced roads in the county. Most of these are of concrete, with a small extent of brick and asphaltic-concrete.

Nashville Votes Million-Dollar Sewer Extensions

A bond issue of $1,000,000 for sewer extensions was authorized by popular vote at Nashville, Tenn., on Sept. 29. A vigorous campaign for the bonds was made, in view of the fact that half the population is without sewer facilities, that there are 12,000 open privy vaults in the city, and that up to Aug. 31 of this year 213 cases of typhoid fever had been reported in Nashville.

Ohio University Erects Buildings for U. S. Airplane School

The Ohio State Emergency Board, composed of the governor, the attorney general, the auditor of state and the chairmen of the two legislative finance committees, has appropriated $80,000 for the erection of four new buildings to be used for the Government aviation school located at Columbus, Ohio, on the grounds of the State University. The money comes out of the fund of $250,000 appropriated each year by the State Legislature for emergencies that may arise in state offices.

The buildings will consist of two frame barracks, one machine gun range and one laboratory. The two barracks buildings will be frame structures, each housing 200 men. The machine gun range has been found necessary because previous practice with these guns behind Robinson laboratory attracted so much attention that a dangerous situation was created. The laboratory itself is to be the most elaborate structure. One end of it will contain hangars, where two airplanes will be placed and used for experimental purposes.

Maintains That Garbage Is Private Property

Right to the garbage from their restaurants and to dispose of it as they see fit so long as the method is sanitary is claimed by J. B. Pantlind and W. W. Lawrence, two restaurant proprietors of Grand Rapids, Mich., who have secured a temporary injunction supporting their claim. The city has been collecting this and other garbage and turning it over to Henry Hartman for feeding to hogs. Originally, the plaintiffs claim, the ordinance under which the city is operating was designed solely for sanitary protection, but for some years past the city has been attempting a monopoly for commercial gain. The plaintiffs want their garbage to feed to hogs on their own farms, outside the city.

Cincinnati Will Vote on New Charter Nov. 6

A home rule charter for Cincinnati, Ohio, has been framed by a charter commission and will be submitted to popular vote on Nov. 6. The home rule section of the charter merely provides that the city "shall have all powers of local self-government and all other powers possible for a ctiy to have" under the state constitution. Beyond this the new charter seems to differ from the present one chiefly in lengthening the terms of appointive officers (some of the latter to eight and even ten years); in adding slightly to the number of officials appointed by the mayor; and in creating the office of director of street railroads and providing for a city-planning commission. The mayor, councilmen and auditor will be elected for terms of four years. Other chief executive officers will be appointed by the mayor. The director of street railroads will succeed to the powers now vested in the mayor and street railroad commissioner and to some of the powers vested in the board of rapid transit commissioners, but apparently his powers will be confined chiefly to regulating street railroad companies.

The planning commission will consist of seven members. Of these five will be the mayor, director of public service and the three park commissioners and two will be citizens appointed to serve for six years, without pay. The commission will have broad planning powers, some of which will be advisory and some exclusive and final, unless overridden by a two-thirds vote of the council. The planning commission will serve as the platting commission of the city. In this respect it appears that its powers will be exclusive over layouts of streets, alleys, commons or other ground for public use, within and three miles outside the corporate limits of the city.

Alvord Put on Illinois Resources and Conservation Board

Governor Lowden, of Illinois, has appointed John W. Alvord, of Alvord & Burdick, hydraulic and sanitary engineers, Chicago, a member of the Illinois State Board of Natural Resources and Conservation, which is to study the resources of the state, the work of its departments under the lines indicated, and advise the governor and the legislature from time to time on matters in which the welfare of the state may be promoted. The other members of the board, all of whom serve without compensation, are: Geology, Prof. Thomas C. Chamberlain; biology, Prof. John M. Coulter (both of the University of Chicago); chemistry, Prof. William A. Noyes; forestry, Prof. William Trelease (both of the University of Illinois.

Mr. Alvord is to advise on water resources. President Edmund J. James, of the University of Illinois, is ex-officio member and will act as chairman of the board.

Hearing To Be Held in Newark on Wanaque Watershed

The North District Water-Supply Commission, Newark, N. J., will hold a hearing at the City Hall on Oct. 18, at which may be represented such municipalities as desire to enter the Wanaque watershed development project. At the hearing the Board of Works will make application to the Water Commission to construct a reservoir and pipe line for an additional water-supply of 10,000,000 gal. daily for that city.

May Stop Burning Garbage

A proposed change in the method of garbage disposal at Minneapolis, Minn., now under consideration by a committee of the city council, would involve an abandonment of the incineration and heat utilization plant as well as giving up the practice of draining garbage and wrapping it in waste paper in kitchens before depositing it in the garbage can. Agitation for a change was started by objectors to the present central loading station and accelerated by the conservation movement sweeping over the country. Three plans for a new method of disposal are before the city council: (1) Delivery by the city to a central point for loading on cars, under a contract with Rogers & Rogers, St. Paul, who offer 50c. a ton if the contract is for three years and 55c. if for five years. (2) Delivery by the city to the United States Engineering Co., of Chicago, which offers to build a reduction plant outside the city and pay prices, not yet made public, depending in part on the length of the contract. (3) A municipal piggery.

The Board of Aldermen have applied to the State Public Safety Committee for $100,000 or $150,000 with which to establish a municipal garbage piggery, the money to come from the $1,000,000 State War Fund at the disposal of the committee. In a report made by F. W. Cappelen, city engineer, before this request was filed with the committee, it was estimated that garbage disposal at a municipal piggery would yield the city a profit of $70,000 as compared with the present net expenditure for garbage incineration at the joint plants for garbage burning and for heating and lighting certain public institutions and some adjoining streets.

Oregon State Highway Department Designs 25 County Bridges

During the present year the State Highway Department of Oregon has drawn plans for 25 county bridges, the total cost of which aggregates about $500,000. Most of the structures are at present under construction. The principal one is the steel and concrete bridge across the Willamette River at Salem, which is being erected by Marion and Told Counties jointly. The cost of this structure is about $250,000, and next in cost comes the proposed concrete arch across the Des Chutes River, being erected by Sherman and Wasco Counties. This new bridge will replace the present toll bridge. Other structures on which work is being done in the highway office are 10 structures for Coos County at $32,000; 10 bridges for Columbia County, totaling $46,000; four bridges for Hood River County, totaling $11,400; three for Wasco County, $14,700; and three structures for Tillamook County, totaling $46,000.

Fewer Granite Paving Blocks Sold in 1916

According to figures reported to G. F. Loughlin, of the U. S. Geological Survey, Department of the Interior, there were sold in 1916 44,795,796 granite paving blocks, valued at $2,288,486, a decrease of nearly 7% in quantity and of nearly 3% in value compared with the figures for 1915. The average price per thousand, however, increased from $48.85 to $51.09. Four of the 18 producing states, Maryland, New Hampshire, North Carolina and Wisconsin, showed increase in quantity and value of sales.

The decrease in quantity in 1916, though smaller than that in 1915, was even more general. As there has been a growing recognition among city engineers and street commissions of the suitability of granite paving blocks for streets supporting heavy traffic, the decrease in quantity of paving blocks sold in 1916 appears due to a decrease in the amount of heavy traffic construction work, rather than to competition with other paving materials.

The quantity and value of paving blocks sold in these and in states producing more than 1,000,000 blocks during 1915 and 1916 were as follows:

	1915	
	Number	Value
Wisconsin	10,229,714	$577,758
Maine	10,910,032	495,327
New Hampshire	4,243,753	205,456
Massachusetts	5,580,441	283,612
North Carolina	4,024,677	191,796
Georgia	3,639,970	108,177
Minnesota	1,859,715	123,940

	1916	
	Number	Value
Wisconsin	11,005,538	$685,622
Maine	8,823,252	430,753
New Hampshire	5,486,815	247,177
Massachusetts	5,204,377	282,640
North Carolina	4,376,383	200,851
Georgia	3,168,927	105,350
Minnesota	1,292,386	85,106

The average price per thousand varied from as low as $32 in California and $33 in Georgia to $66 in Minnesota and Rhode Island. There was little geographic significance to differences in average price, other than a relatively low price for labor in the Southeastern States. The principal controlling factor was apparently the ease with which the blocks could be prepared. Thus the average prices in New York ($45) and in Georgia ($33), where easily worked granite blocks are abundantly produced, were in contrast to that in Massachusetts ($53), where some of the granites are unusually hard, and with those in Wisconsin ($62) and Minnesota ($66), which are characterized by hard granites.

The value of sales of "durax" granite paving, reported by two producers, is not included in the foregoing figures.

Interior Department Wants Engineers To Classify Lands

The large appropriation for the work of classifying public lands in Western States with regard to their value for grazing and raising forage crops having become available in June, Secretary Lane, of the Interior Department, has instructed the United States Geological Survey to undertake the work on the more than 20,000,000 acres scattered through 15 states. A number of qualified men are urgently needed who will serve on the survey staff after certification by the Civil Service Commission. Open competitive examinations have been announced for the position of junior land classifier at salaries of $1080 to $1200 a year, assistant land classifiers at salaries of $1500 to $1800 a year, and classifiers at salaries of $1800 to $2400. Expenses while on duty will be paid by the survey.

Applicants will not be subjected to formal written examination nor will they be required to assemble for examination in any particular place, but will merely have to file with the commission certificates as to their training and experience. Recent college graduates who have specialized in agricultural or civil engineering are especially desired, though there are openings in the higher positions for men who are trained in plant ecology, geology and forestry. Further information can be secured by addressing the Director of the Geological Survey, at Washington, and proper application forms and detailed instructions as to their use can be obtained from the Civil Service Commission in Washington or any of its local secretaries.

The completion of classification is hoped to result in a large increase in the production of live stock.

War Conditions Postpone Another Convention

Owing to conditions arising from the war, the Society for Street Cleaning and Refuse Disposal of the United States and Canada has decided to abandon its annual convention this year. The labor situation is so acute that officials in charge of street cleaning and refuse disposal feel reluctant to leave their work for even the short time necessary to attend a convention.

Charleston Buys Water-Works

The water-works plant of the Charleston Light and Water Co., Charleston, S. C., passed into the hands of the city named on Oct. 1. The purchase price was $1,360,000. Bonds to the amount of $140,000 for extensions have been authorized. For some years the works were under the direction of John M. Diven, now superintendent of water-works at Troy, N. Y., and secretary of the American Water-Works Association. The manager of the works under municipal ownership is J. E. Gibson, who was principal assistant engineer on the construction of the works for the American Pipe and Construction Co.

PERSONAL NOTES

CAPT. HOWARD SCOTT, with the Imperial British Munitions since the beginning of the war, and formerly of the contracting firm of Scott & Law, Buffalo and Rochester, N. Y., has accepted a position as superintendent with the Bates & Rogers Construction Co., at Camp Grant, Rockford, Ill. Abroad he was employed at the Woolwich Arsenal constructing works for electric products, acetone and cordite. Toward the end of his 28 months' service he was sent to the Rhone Valley, France, on hydro-electric plant construction. Testing high explosives on the Nancy-Verdun front he was disabled six months ago and returned invalided after four months in the hospital. From 1907 to 1910 Captain Scott was with S. Pearson & Son, London, on hydro-electric development and railway and dam construction in Central America and Mexico until the Mexican difficulties curtailed further activities in that country. He was then for two years with the Brazilian Government on the Paraña hydro-electric and irrigation development, and later for a few months with the Ambursen Hydraulic Construction Co. on the Eugena Dam in Ontario.

GARDINER S. PLUMLEY, who for the past 10 years has been connected with the Blue Creek Coal and Land Co. and the Kanawha & West Virginia Railroad Co., in the capacity of chief engineer, has opened an office at Charlestown, W. Va., to engage in private practice of civil and mining engineer. He will still retain his connection with the Blue Creek Coal and Land Co. as consulting engineer.

PAUL O. SULTZER, formerly with the Montana Power Co., has purchased the Inter-Mountain Map Co., of Boise, Idaho.

R. F. MACDOWELL is located at Camp Sherman, Chillicothe, Ohio, as resident engineer representing R. Winthrop Pratt, who is consulting engineer on this work.

ALBERT H. BAUM, JR., is at present superintending the construction of the new high school being erected for the Redfield Independent School District No. 20, of Redfield, S. D. Mr. Baum is representing William B. Ittner, architect, St. Louis, who designed the building.

CAPT. J. MCLEAN JASPER, formerly with Alvord & Burdick, Chicago, is now in charge of signaling instructions at the English Officers' Cadet School, near Maresfield, Sussex, England. At this point there are about 1000 cadets training for the heavy artillery, they being kept under instructions for a period of about four months. The camps are turning out about 125 men every two weeks. Early in the war Captain Jasper, who lacked but ten days of getting his final United States citizenship papers, left for England and was placed in command of a battery of field guns. Later he was in charge of constructing horse standings for the 36th Division, and then was placed in charge of gun-pit construction and on communication work. He was transferred to the Royal Engineers, but was wounded before he could assume his new work. He then entered the Reserve Training Brigade as examiner of gunners upon his recovery, and was later placed in command of the school of signaling mentioned above.

JOHN T. KEENAN, an assistant engineer for the Providence Water-Supply Board, has been commissioned major in the Engineer Officers' Reserve Corps.

C. M. HALL was elected president of the Atlanta Association of Members of the American Society of Civil Engineers. Mr. Hall is a consulting engineer, with offices in Atlanta. PROF. W. B. BRANCH, of the civil engineering department of the Georgia School of Technology, was elected vice president, and W. C. SPIKER was elected secretary and treasurer.

JAMES K. JAMES, who for the past seven years has been resident engineer of the fuel oil department of the Southern Pacific Co., at Taft, Calif., has been commissioned captain in the Engineer Officers' Reserve Corps, and is now at Vancouver Barracks, Washington.

HERBERT M. PALMER is at present in the employment of the Staten Island Shipbuilding Co., Mariners Harbor, Staten Island.

CAPT. D. M. OLTARSH has been assigned to Newark, N. J., for the construction inspection on materials which are being made for the Government.

F. H. LANE, manager of the department of examinations and reports of H. M. Byllesby & Co., Chicago, will have temporary charge of the engineering and construction department of this company, succeeding CAPT. W. R. THOMPSON, now located at Battle Creek, Mich., on cantonment work; and A. H. FAYCE, who has joined the Second Reserve Officers' training camp, has left for Fort Sheridan.

ROY E. WENK, formerly draftsman for the Public Service Co. of Northern Illinois, is at present in charge of construction of a milk condensary at Fox Lake, Wis., for Libby, McNeill & Libby, of Chicago.

M. O. ELDRIDGE, of the Office of Public Roads and Rural Engineering, whose article on "Serial Bonds" appeared in the issue of Aug. 30, has just returned from a trip of inspection through the Southern States.

MANCHE O. BENNETT, division engineer of the eastern Oregon highway district, at Pendleton, and FRANCIS E. KURTZ, district highway engineer of Jackson County, recently tendered their resignations to Herbert Nunn, state highway engineer. No appointments have been made to fill these vacancies, and the work being done by them will be taken over by enlarging other divisions.

W. C. HAWKINS has been appointed engineer, maintenance-of-way, of the Coal and Coke Ry., with office at Cassaway, W. Va., succeeding F. D. COSNER, resigned.

J. H. GUMBES, formerly superintendent of the Philadelphia Terminal Division of the Pennsylvania R.R., has been appointed general superintendent of the Western Pennsylvania Division. Graduating from the University of Pennsylvania in 1888, Mr. Gumbes entered railroad service as a rodman on the Middle Division of the Pennsylvania R.R., being transferred to the maintenance-of-way department in 1890 and promoted to assistant supervisor at Freeport, Penn., in 1891. Transferred to a similar position at Mifflin, Penn., in 1893, he was promoted to supervisor at Millersburg in 1897, and in 1899 was transferred to the Monongahela Division as supervisor, returning to Mifflin as supervisor in 1900. In 1901 he was transferred to the position of supervisor at Florence, Penn., and in 1903 was promoted to division engineer in the Monongahela Division. In 1905 he was transferred to division engineer of the West Jersey & Seashore, and was made division engineer of the Pittsburgh Division in 1907. Promoted to assistant superintendent of the Pittsburgh Division in 1911, he was made superintendent of the Renovo Division in 1913.

W. K. PALMER, who for 16 years has been engaged in consulting engineering practice as the head of the firm of W. K. Palmer Co., engineers, Kansas City, Mo., has accepted a commission as major in the Engineer Corps, U. S. A., and in consequence will discontinue his practice and the business of the company of which he is the head for the period of the war.

H. R. ADAMS, formerly on the Federal-aid highway improvement work in northern Alabama, is at present connected with the topographical branch of the United States Geological Survey, with headquarters at Washington.

E. N. TODD, civil engineer and superintendent of construction, Quartermaster Corps, U. S. A., has recently been transferred from Ft. Morgan, Ala., to the Quartermaster Depot, St. Louis, Mo., where he will have charge of the construction of several large warehouses. Mr. Todd returned last September from the Philippine Islands, where he spent one year in the department quartermaster's office as designing engineer.

L. R. P. REESE has resigned his position of assistant city engineer of Fort Collins, Colo., to join the second training camp for reserve officers at the Presidio, California.

CAPT. T. M. WARD, engineer of bridges and buildings on the Seward Division of the Alaskan Government

Rys., has been assigned to the Engineer Corps, U. S. A., and ordered to report at the cantonment at American Lake, Washington. Captain Ward served in the Spanish-American war as captain of volunteers.

ROBERT W. THOMPSON has been appointed district engineer by the Government of British Columbia and will have headquarters at Kamloops.

OBITUARY

LIEUT. EDWIN AUSTIN ABBEY, of the Fourth Canadian Mounted Rifles, has been killed in action. Born in Mt. Holly, N. J., he graduated from the University of Pennsylvania and became connected with the construction and valuation department of the Canadian Pacific Ry. In October, 1915, he enlisted in the Second Canadian Pioneer Battalion, and after being in training camps both in Canada and in England, saw his first service at Ypres, where he was wounded on Apr. 23, 1915. After his recovery he was commended for a commission, took the course at the Officers' Training School at Shorncliffe and returned to the front December, 1916, as lieutenant of the Fourth Canadian Mounted Rifles. Since that time he was in continuous service, being killed by an enemy sniper at Vimy Ridge, Apr. 10, 1917.

ROYAL CANFIELD PEABODY, president of the Combustion Engineering Corporation, died Sept. 15.

EDWARD MEAD, at one time city engineer of Nashville, Tenn., and later connected with the engineering department of the Nashville, Chattanooga & St. Louis R.R., died in Nashville, Sept. 16.

CRAIGE RIDGWAY, for 54 years head of the Craige Ridgway & Son Co., manufacturers of steam hydraulic machinery, Coatesville, Penn., died recently.

BUSINESS NEWS

To Investigate Slack in New York City Building

Progress is being made in the movement inaugurated by the New York City Building Materials Exchange to stimulate new construction work, according to reports recently received. At a meeting held Oct. 2 in the office of the president of the Borough of Manhattan, Elliott Smith, president of the exchange, appointed five subcommittees to care for various phases of the present slack condition of building. These committees are: (1) On the demand for buildings, (2) on the supply and price of building materials, (3) on the supply and price of labor, (4) on the supply and price of mortgage money, (5) on building laws.

C. J. Curtin, a member of the exchange who has been prominently identified with the movement, said to a representative of the *Engineering News-Record* that owners, loaning institutions and tenants must realize that conditions are now at a different level, and that they must therefore adjust themselves to the new conditions. This statement, Mr. Curtin says, is particularly true of the loaning institutions. A fairer appraisal must be made upon which loans should be based. These new appraisals must not be based upon values as they existed last year. Since there is little likelihood that prices will be adjusted on a lower basis for a long time to come, it costs more today to produce a building than ever before. The effect of Federal price revision will only influence building at the present time to a certain extent, and it becomes necessary therefore to obtain better loans in order that industry may keep step with the demands of the Government and its citizens.

Goethals Heads Wright-Martin Airplane Company

At a meeting of the directors of the Wright-Martin Aircraft Corporation, held Oct. 4, Maj. Gen. George W. Goethals was elected president. Since his retirement as general manager of the Shipping Board as the result of friction with Chairman Denman, he has been engaged chiefly in undertakings of his engineering firm, Goethals, Jamieson, Houston & Jay. As head of the company manufacturing airplanes, he will continue to act in an advisory capacity on consulting engineering work.

Notes from

MAKERS OF PLANT AND EQUIPMENT

Walter Lochen, 86 Michigan St., Milwaukee, has been appointed sales representative in Milwaukee and vicinity of the National Fireproofing Co., Chicago Metal Weather Strip Co. and the Donley Bros. Co., Chicago.

The United States Terminals Co., 400 Lewis St., Weehawken, N. J., has been incorporated with a capital of $1,000,000 to build piers, wharves, etc. The incorporators are Lionel Isaacs, William F. Harney and Frank Galland, all of 400 Lewis St., Weehawken.

R. M. Howard, who was formerly assistant construction engineer for the Berger Manufacturing Co., Canton, Ohio, is at present in the sales department of the Trussed Concrete Steel Co., at Youngstown, Ohio.

The Portable Machinery Co., Inc., Passaic, N. J., has issued a leaflet describing its Pomato Scoop Conveyor for loading, unloading, storing or reclaiming coal, stone, sand and manufactured products of a similar character.

The Patterson-Kelley Co., Inc., 26 Cortlandt St., New York City, has been formed from a combining of the interests of **Frank L. Patterson & Co.** and **Benjamin F. Kelley & Son.** The new firm will specialize as water-heating engineers and manufacturers of heaters.

The Worthington Pump and Machinery Corporation announces the opening of a new branch sales office in the American Trust and Savings Bank Building, Birmingham, Ala. This new office will take care of the portion of the very large territory hitherto controlled by the Atlanta office and has been established with a view of rendering better service to the trade and affording more direct connections with the home office to that portion of the territory which will come under its direction. Edward Stauverman, formerly with the Atlanta office, will be in charge of the new branch. The territory controlled from the new office will be all of the State of Alabama, excepting the following counties: Choctaw, Clark, Monroe, Washington, Conecuh, Mobile, Baldwin and Escambia, and all of the State of Florida, except the counties of Okaloosa, Escambia and Santa Rosa, and all of that portion of the State of Georgia south of the Seaboard Air Line running from Columbus, Ga., to Savannah, Georgia.

The El Paso Bridge and Iron Co., El Paso, Tex., has contributed to the present war the following men of its staff: E. P. Rankin, Jr., captain, engineers, Fort Leavenworth, Kan.; Henry E. Robertson, captain, infantry, Camp Travis, San Antonio, Tex.; L. L. White, captain, artillery, Camp Travis, San Antonio, Texas.

The Blaw-Knox Company, of Pittsburgh, owing to conditions created by the war, has decided to close its Boston office until peace is declared. All inquiries and all work in the Boston territory will be handled through the company's New York office, 165 Broadway.

The Asbestos Protected Metal Co., of Pittsburgh, announces the appointment of Ole K. Olsen, 822 Pardido St., New Orleans, as sales agent for the State of Louisiana and the southern portion of Mississippi.

W. P. Anderson, president of the Ferro-Concrete Construction Co., of Cincinnati, has gone to Belvoir, Va., on duty as captain, Engineer Officers' Reserve Corps.

The Atlas Cement Construction Co., Ltd., of Montreal, is building a self-propelling reinforced-concrete ship, with a hull varying in thickness from 3 to 5 in. The ship's dimensions will be: Length, 125 ft.; beam, 22 ft.; molded depth, 13 ft. Metal for the keel is in place and many of the structural ribs for the hull have been set up.

J. K. Robinson, Chilean representative of the Westinghouse Electric Export Co., died at his summer home, Naples, Maine, Sept. 7.

The T. H. Letson Co. announces the opening of an office at 50 Church St., New York City, for the handling of hoisting and power machinery and contractors' equipment. Mr. Letson has

associated with him Frederic Glander, electrical and mechanical engineer. Because of the unusual conditions prevailing and the difficulty of securing new equipment promptly, a used machinery department has been organized and the company is prepared to quote on requirements in this line. Mr. Letson for 17 years was New York sales manager for the American Hoist and Derrick Company.

The officers of the American Steel Export Co., New York, on Sept. 13, at the Waldorf, gave a farewell dinner of twenty covers to Samuel Armstrong Benner, who has resigned his position as general sales manager of the company to become vice president of the Federal Export Company.

The Macleod Co., Cincinnati, Ohio, in order to take care of expanding business in sand blast equipment and metallurgical furnaces, has enlarged its plant and increased its capital to $100,000.

H. E. Linden, of the Beckman & Linden Engineering Corporation, of San Francisco, is making an extended trip throughout the East in the interest of his own company and also in the interest of the Pacific Electro-Metals Co., of which the Beckman & Linden Engineering Corporation are the engineers and managers.

TRADE PUBLICATIONS

The Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill., has issued Book No. 246, illustrating and describing electric hoists, and Book No. 342, entitled "Casings and Lubrication for Link-Belt Silent Chain Drives."

The Marion Steam Shovel Co., Marion, Ohio, has issued a new general catalog on steam and electric shovels, dredges, excavators, ditchers, etc.

David White Co., 419-421 East Water St., Milwaukee, Wis., has issued a new catalog and price list of surveyors' instruments.

Locomotives for industrial and contractors' service are described in Record No. 86, just published by the Baldwin Locomotive Works, Philadelphia, Pennsylvania.

The Whiting Foundry Equipment Co., Harvey, Ill., has issued three new catalogs, as follows: Catalog No. 129 on brass foundry equipment; Catalog No. 129 on the Whiting converter; Catalog No. 131 on the Whiting cupola.

Bulletin W-308, covering duplex piston pattern pumps, and Bulletin W-400, on outside packed plunger pattern pumps, have been issued by the Worthington Pump and Machinery Corporation, 115 Broadway, New York. These bulletins give tables of sizes and capacities.

The Walter A. Zelnicker Supply Co., St. Louis, Mo., is sending out Bulletin No. 220 on rails, locomotives, cars, steel piling, etc.

"Machines That Do the Work of Men" is the title of an illustrated booklet issued by the Allied Construction Machinery Corporation, of New York, a coöperative selling organization under the management and direction of the American International Corporation. Explanatory text and typical views show the varied service to be expected from power-driven machinery such as concrete mixing and spouting outfits, revolving shovels, grab buckets, heavy steam shovels, road-grading equipment, rock crushers, steam rollers, tractors, trenching machines, pile drivers, etc.

APPLIANCES AND MATERIALS

Roller in Lumber Truck Body Expedites Unloading

The Chicago Pneumatic Tool Co., of Chicago, maker of the "Little Giant" motor trucks, are turning out trucks fitted with a special body for lumber dealers. In the platform of the body are five rollers projecting above the floor, so that the load rests on them. When the loaded truck is to be unloaded, a crank is applied to one of the rollers and the entire load, moving as a unit, is backed partly off. A chain is then put around the pile and the timber is placed crossways on the ground. The load is then turned off backward by cranking one of the rollers until one end rests on the ground. Then another chain is placed around the pile at the other end and the truck is run a few feet ahead so that the load drops in a perfect pile. The single timber between the pile and the ground allows the chains to be removed quickly. Portable platforms provided with similar rollers are used for loading lumber out of cars and transferring the load as a unit to these trucks.

Trackless Electric Locomotive with Dumping Body Goes Anywhere

The latest thing in industrial trucks appears to be a small industrial electric (storage-battery) locomotive fitted with flangeless wheels and rubber tires and carrying a Lee side-dumping hopper of 1½-yd. capacity, made by the Buda Co., Railway Exchange Building, Chicago. The overall dimensions of the machine are: Length 8 ft., width 4 ft., height 4 ft. Similar units are made with the body dumping front or back.

Rotary Machine Screens Stone Ballast Alongside Track

A rotary screen for cleaning stone ballast alongside the track has been patented by G. C. Harris, of Chapman, Kan., and used by him on the Atchison, Topeka & Santa Fe Ry. The machine is now being put on the market by the Madden Co., of Chicago.

A rotary perforated screen with an inclined belt conveyor feeding into one end is mounted on skids placed at the side of a motor section car having a 3-hp. gasoline engine. The screen and conveyor are outside of the track but parallel with it. They are not permanently attached but can be removed for transportation. The screen is 4½ ft. long and is revolved at a speed to suit the character of the material handled. It is driven by a bevel gear, with chain drive from the engine shaft to the bevel pinion shaft, as shown. The weight of the machine complete is about 600 pounds.

The stone ballast shoveled from the track is thrown upon the belt, which delivers it to the upper end of the screen. The cleaned stone is delivered from the end of the screen along the side of the track, or between the tracks, the machine being moved ahead as the work progresses. The dirt which passes through the holes in the screen is caught on a belt conveyor and discharged by a chute or apron at one side of the machine. It may be discharged on the roadbed or into a wheelbarrow, etc., for removal.

BALLAST SHOVELED ONTO BELT IS RETURNED TO TRACK CLEANED

With a gang of 14 men, 12 will dig out the ballast and shovel it into the conveyor, while the others will attend to the machine and the handling of the dirt. This gang can screen 2000 ft. of track in a 10-hr. day. By the old method of using ballast forks they could clean only about 300 ft. In one test, a gang of 11 men cleaned 1780 ft. of track in 10 hours, during which time they had to remove the machine for 18 trains. On the same day a gang of 45 men with ballast forks cleaned only 1400 ft. of track in 11 hours.